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STUDY OF THE U.S.A.F.
TACTICAL AIR CONTROL SYSTEM (TACS)

23 October 1970

SYSTEM DEVELOPMENT CORPORATION • 2500 COLORADO AVENUE • SANTA MONICA, CALIFORNIA 90406

81

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TECHNICAL MEMORANDUM

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STUDY OF THE U.S.A.F.
TACTICAL AIR CONTROL SYSTEM (TACS)
for the
U. S. Army Missile Command

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ABSTRACT

This information search study provides a description of the Tactical Air Control System (TACS) and the improvement program 407L. TACS is comprised of four major subsystems: Aircraft Control and Warning, Tactical Air Support, Air Traffic Control, and Command Communications. Operating elements and major equipment components of the four subsystems are described with particular emphasis placed on the CRC/CRP AN/TSQ-91 of the Aircraft Control and Warning subsystem.

TABLE OF CONTENTS

TABLE OF CONTENTS

TABLE OF CONTENTS

LIST OF ILLUSTRATIONS

FOREWORD

This document has been prepared by the Huntsville Office of the System Development Corporation in accordance with the provisions of U.S. Army Missile Command Contract DAAH01-70-C-0983.

Information sources included the documentation listed in the Bibliography and discussions with Air Force and contractor personnel associated with the Tactical Air Control System improvement program--407L. Every effort has been made to ensure that the data are complete and accurate as of the date of preparation.

Publication of this technical documentary report does not constitute Department of the Army approval of the report.

SECTION 1. TACTICAL AIR CONTROL SYSTEM (TACS)

The Air Force Tactical Air Control System (TACS) is a mobile, lightweight, detection, display, and control system that provides the means for the Tactical Air Force Commander to plan, direct, and control air operations and to coordinate air operations with ground and naval forces. In 1964, Hq. USAF determined that the system required upgrading for the post 1970 tactical air environment, and established the 407L (TACS) Program to accomplish the necessary upgrading.

Phase I of the program provided for immediate improvements to operational capability through acquisition of state-of-the-art equipments requiring only minimal modifications for incorporation into the system. Phase I has been completed.

Phase II improvements are to provide for a semi-automated capability at the CRC/CRP, improvements to operations center shelters, and an improved communication capability for all centers. Phase II is currently in Category II testing.

Phase III (1971-1976) will concentrate on modernization (automation/miniaturization) throughout the system.

This document discusses Phase II results of the 407L (TACS) Program.

TACS is composed of four subsystems (Aircraft Control and Warning, Tactical Air Support, Air Traffic Control, and Command Communications) which are comprised of combinations of nine basic elements or operating locations. The four subsystems and their respective functional elements are discussed below:

- Aircraft Control and Warning Subsystem (AC&W)

  The AC&W subsystem performs planning and coordination of the air effort, coordinates surveillance (detection and tracking), displays and disseminates air intelligence information, and controls tactical aircraft missions. The elements which comprise this subsystem are the Air Force Component Command Post (AFCCP), Tactical Air Control Center (TACC), Control and

Reporting Centers (CRC), Control and Reporting Posts (CRP), and the Forward Air Control Posts (FACP). The AFCCP and TACC are usually collocated and, therefore, will be discussed together.

- <u>Tactical Air Support Subsystem (TAS)</u>

  The TAS subsystem relays requests from the Army for close air support and reconnaissance. It directs and controls these activities, and is integrated with Army field operations. The elements which comprise this subsystem are the Direct Air Support Center (DASC) and the Tactical Air Control Parties (TACP).

- <u>Air Traffic Control Subsystem (ATC)</u>

  The Air Traffic Control Subsystem provides means for control of air traffic within an assigned operational area. It is composed of communication equipment, navigational aids, and enroute and terminal air traffic control and regulation equipment. The elements which comprise this subsystem are the Terminal Air Traffic Control Facilities (TATCF) located at a Tactical Air Base (TAB) and the Air Traffic Regulation Center (ATRC) collocated with the CRC.

- <u>Command Communications Subsystem</u>

  The Command Communications Subsystem includes part of the communication equipment located at the AFCCP/TACC and TAB. It provides both intra- and intercommunications for these elements. No elements are specifically assigned to this subsystem.

All elements of the TACS utilize high frequency/single sideband (HF/SSB) links for ground-to-ground communications. These links are supplemented as soon as base establishment is complete with direct microwave or troposcatter communication links between most of the elements. Thereafter, the HF links are used for backup communications and to expand networks that will be established between the TACC, CRC, CRP, DASC, and the air bases for scramble information exchange, air traffic control, and air support. The elements possess ground-to-air capabilities (UHF and VHF) as an integral part of the respective networks.

The deployment configurations of the TACS equipments are a function of the tactical capacity required by the Tactical Air Force Component Commander in his support of deployed tactical forces and the Army tactical field missions. In an actual operational environment, elements can be added or deleted, thereby providing flexibility to the element's functional capacity.

1.1 AIRCRAFT CONTROL AND WARNING SUBSYSTEM (AC&W)

1.1.1 Air Force Component Command Post/Tactical Air Control Center Element (AFCCP/TACC)

The AFCCP is the headquarters facility for the Air Force Component of a joint command and is the operating location where general planning, command, administrative, and logistics supervision operations are conducted. It includes the command section and key staff agencies representing operations, intelligence, logistics, communications, weather, and field support activities.

The TACC, usually collocated with the AFCCP, is the operations center of the AFCCP and the focal point for all air activity within TACS. The TACC plans and coordinates the employment of tactical air effort and air control functions in the area of operations. It is composed of two distinct and separate agencies: (1) Combat Operations Weapons Employment, normally referred to as Current Operations, and (2) Combat Operations Plans, normally referred to as Current Plans. The TACC:

- Provides centralized control of the Air Force effort.
- Exercises operational control of all elements of the Tactical Air Control System.
- Recommends allocation of air effort for close air support, tactical reconnaissance, and air defense.
- Plans counter-air, air interdiction, airlift, air rescue, and tactical air reconnaissance operations.

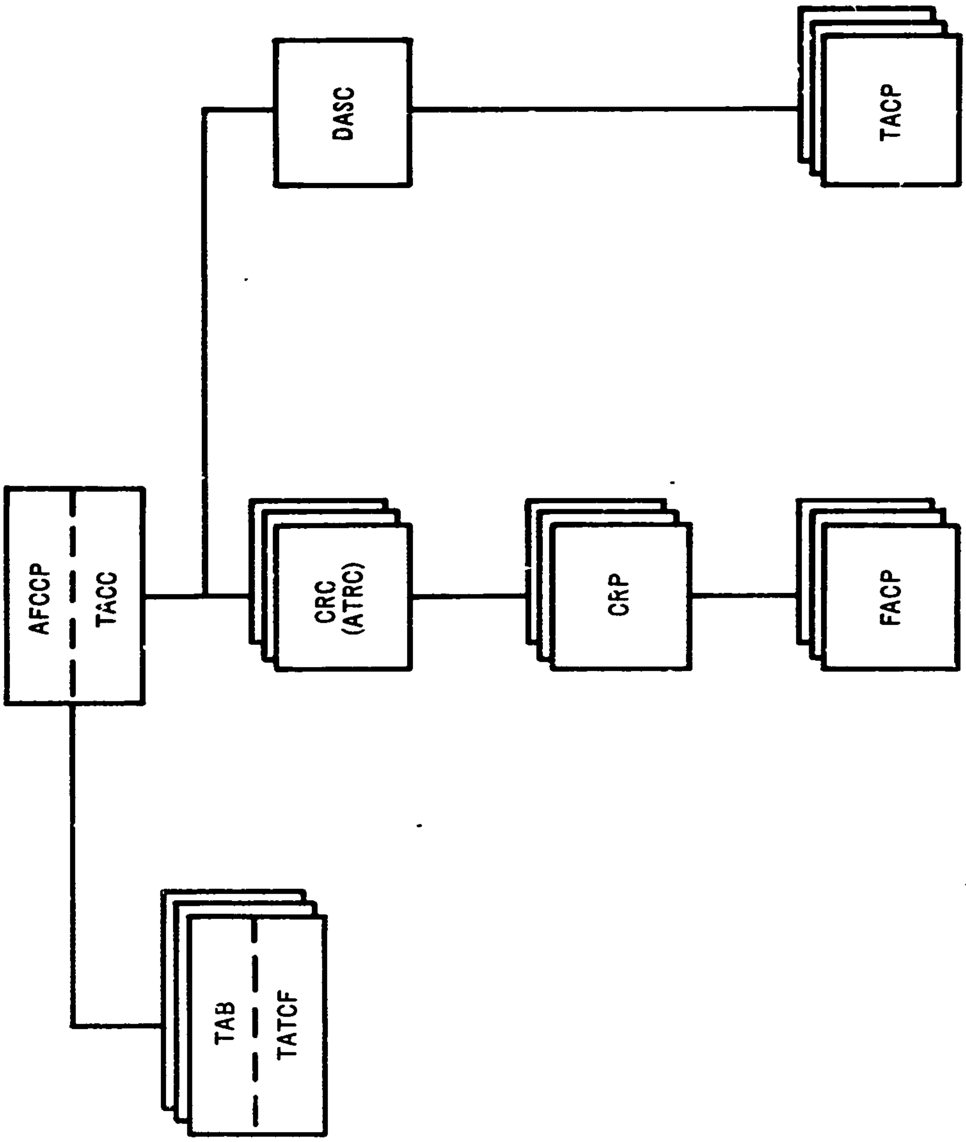

Figure 1. TACS Operational Control (Nine Basic Elements)

- Plans and commits sorties for preplanned close air support and reconnaissance missions based on Army requirements.
- Allocates sorties to the Direct Air Support Center (DASC) to satisfy Army requirements for immediate close air support.

The TACC is designed with sufficient flexibility and modularity to operate in conjunction with the highest ground force field command responsible for planning and directing tactical operations. Normally, this may be expected to range from division (or smaller size forces) up to a Field Army. The functions of the TACC at any of the force levels are essentially the same; however, the scope and volume of activities vary according to the spectrum of required offensive and defensive air operations. The principal facilities and equipment which comprise the TACC are briefly discussed in the following paragraphs.

1.1.1.1 TACC Operations Center (AN/TSQ-92). The Operations Center provides the facilities to perform the Current Operations and Current Plans functions of the AFCCP/TACC. The center contains desk positions, manually posted displays, and communications equipment necessary to support operators in the accomplishment of the tactical air control mission. It has the option of deploying in incremental modules (inflatable shelters) ranging from a minimum which has 47 operational positions, to a maximum configuration which has 80 operational positions. The number and types of modules for each deployment configuration is based on the scope of operations. The Operations Center employs a manual method of operations and no automatic data processing facilities are provided. This method consists of the use of manual plotting techniques on display boards, voice communications and written records for coordination and bookkeeping functions, and manually operated fragmentary order preparation devices. The communication equipment includes secure and non-secure telephone equipment as well as teletypewriter equipment (see Figure 2).

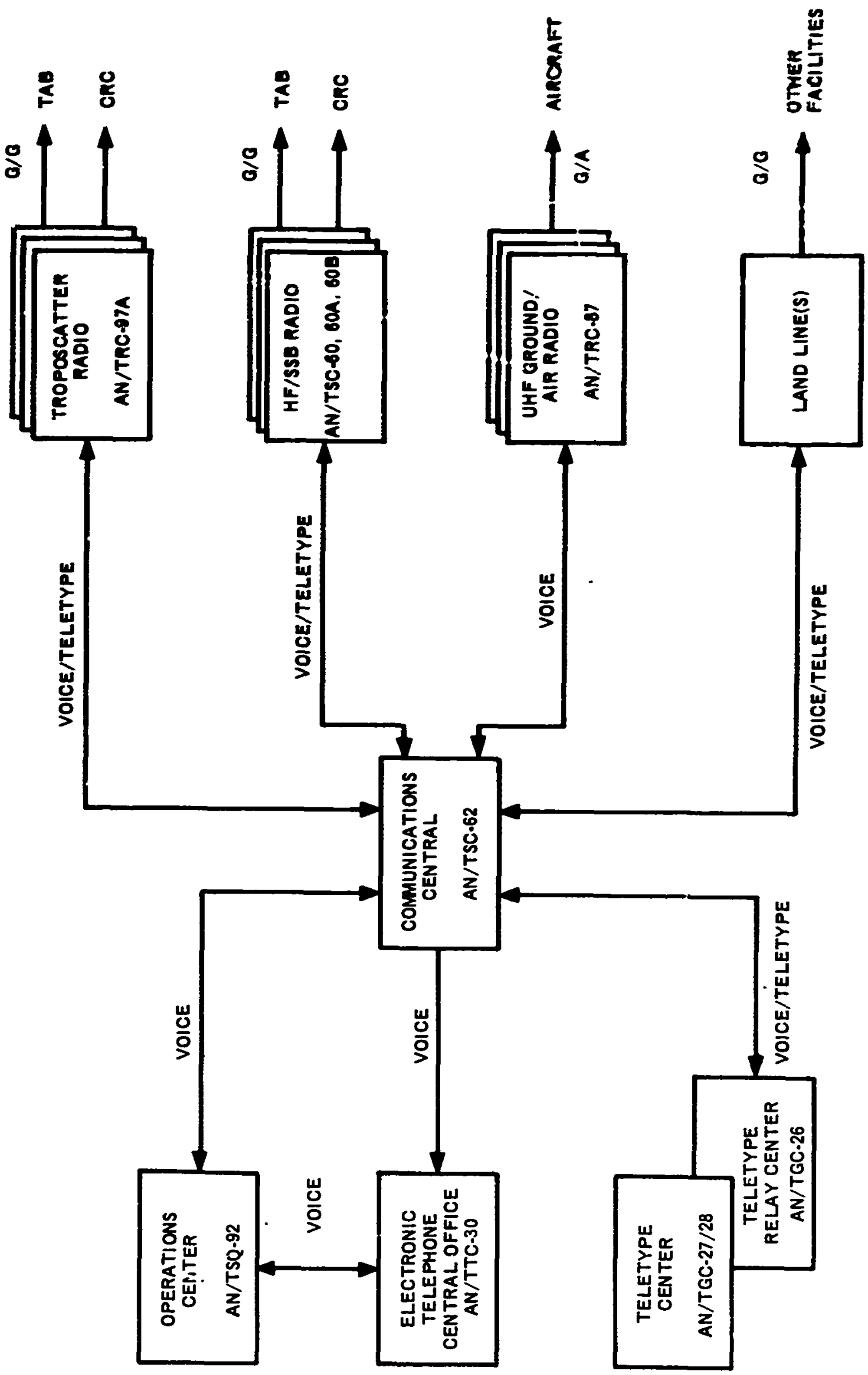

Figure 2. AFCCP/TACC Equipment Diagram (Typical)

1.1.1.2 <u>Communications Central (AN/TSC-62)</u>. The AN/TSC-62 serves as the focal point for the dispersion and interface of most intra- and intersite communications lines in the field deployment. It is capable of quick operation after arrival on site and provides connections to all other onsite communications facilities such as switchboards, telephone switching centers, operation centers, teletype centers, radio sets, and long-line wire circuits. In addition to the patching capability, the central exercises a continuous supervision of the operating condition of communication equipments and is used to perform circuit and channel tests on these equipments.

1.1.1.3 <u>Electronic Telephone Central Office (AN/TTC-30)</u>. The AN/TTC-30 performs local and long distance switching functions for inter- and intrasite telephone communications. It is capable of interfacing with manual tactical switchboards, automatic dial centrals, Army tactical telephone systems (AN/TTC-25) and the DOD autovon system. It also provides automatic alternate routing of calls according to traffic load at that instant and preemption of nonessential calls by priority marking.

1.1.1.4 <u>Teletype Relay Center (AN/TGC-26)</u>. The AN/TGC-26 is a manual torn-tape relay facility capable of transmitting, receiving and relaying teletype messages over 24 full duplex teletype circuits, 18 of which are cryptographically secured. The AN/TGC-26 is used only in the TACC complex.

1.1.1.5 <u>Teletype Center (AN/TGC-27/28)</u>. The AN/TGC-27 and AN/TGC-28 Teletype Centers are designed to perform the message preparation, acceptance, and delivery functions for the AFCCP/TACC and the Tactical Air Bases. The AN/TGC-27 will terminate three full duplex teletype circuits and cryptographically secure these circuits. The AN/TGC-28 is similar, but has an increased capability of 5 circuits. The centers are capable of off-line preparation of teletype tapes; monitoring, patching, and testing of equipment and circuits; and limited relay of incoming messages.

1.1.1.6 Troposcatter Radio (AN/TRC-97A). The AN/TRC-97A is a tactical two-way (ground-to-ground) communication terminal used in conjunction with a similar terminal in the 4400- to 5000-MHz (SHF) band by means of tropospheric scatter, line of sight (LOS) and obstacle gain diffraction propagation. The power output is 1 KW, and the nominal range is 100 nautical miles. When utilized in conjunction with automatic switchboards, the combination will permit direct or alternate routing of voice communication among the deployed TACS operating locations. The AN/TRC-97A provides simultaneous two-directional communications on all information channels (full duplex, multichannel) using telephone and teletype. There are 24 voice channels available for telephone and Frequency Shift Keying (FSK) data. The teletype multiplex equipment can multiplex 16 teletype channels into any one of the 24 voice frequency channels to provide a capability of 16 teletype channels along with 23 voice and/or FSK data channels.

1.1.1.7 UHF/AM Radio (AN/TRC-87). The AN/TRC-87 provides the primary ground-to air voice communications capability. The radio is a transportable, militarized set which provides two-way communications between the operations center and airborne aircraft. Its nominal range is 200 statute miles. The set contains five simplex channels of UHF/AM in the 225- to 200-MHz range at a 100-watt power output. The set can be operated through a remote control system. Four of the five channels are manually tuned to any of 3500 frequencies. These preselected fixed-frequency voice channels are then available at the remote operating site. The fifth channel is automatic. It can be preset to 21 of the 3500 frequencies. At the remote site, these 21 channels can then be automatically selected. Thus, a total of 25 channels are available to the operator (who can be located up to 5 miles away from the transceiver).

1.1.1.8 HF/SSB Radio (AN/TSC-60, A, B). The AN/TSC-60, AN/TSC-60A, and AN/TSC-60B are utilized to satisfy requirements for point-to-point and ground-to-air HF communications. They may be used to establish long haul communications to a DOD communication system entry point or rear main operating base; medium

range communications between Tactical Air Bases or from the AFCCP/TACC to remote operating locations; and short range communications between operating sites of the TACS where broadband links cannot be established due to terrain or distance. The AN/TSC-60 has the capability to provide communications in the 2- to 30-MHz region. Peak envelop power (PEP) for the AN/TSC-60 is 1 KW; for the AN/TSC-60A is 2.5 KW; and for the AN/TSC-60B is 10 KW. Each has the following capabilities:

- Simplex or duplex operation
- Up to a maximum of four speech plus duplex telegraph channels in each radio set, or three channels of voice and multiplexed telegraph in the fourth voice channel
- Digital data rates up to 2400 bits per second (bps)
- Provision for control and monitoring of each radio set from a remote location at distances up to 1/4 mile.

1.1.2 Control and Reporting Center Element (CRC)

The CRC is the prime radar control facility in TACS. It is subordinate to the TACC but the CRC is the focal point of all interface with other services' command and control facilities. It utilizes radar to control in-flight aircraft and perform air surveillance within its assigned area of a combat zone. The CRC coordinates and controls the aircraft control and warning radar networks of the CRC's subordinates, i.e., CRP and FACP, and furnishes air situation information to the TACC. As such, it is the manager of the AC&W capability. In addition, it has the capability to collect, display, evaluate, and distribute information on air activity within its sphere of influence. Collocated with the CRC is the Air Traffic Regulation Center (ATCR), responsible for coordination of air traffic with other military and civilian organizations operating in the area.

The size of the CRC deployment is expandable through three configurations (minimum, medium, and maximum) depending on the force level supported. The functions of the element do not change with a change in configuration. Each configuration is also capable of acting as an alternate TACC with only a

minimal increase in equipment. Typical equipment configuration for the CRC is shown in Figure 3. The communication equipment is described in subparagraphs of 1.1.

For a more detailed discussion on the CRC and AN/TSQ-91 capabilities, see Section 2 of this document.

1.1.2.1 CRC Operations Center (AN/TSQ-91). The AN/TSQ-91 is the heart of the CRC. It consists of inflatable shelters which have positions for operational personnel and data processing, display, and telephone terminal equipment. Basically, a change in the CRC's configuration is accomplished by adding Group Display, Console, and Air Conditioning Modules to the AN/TSQ-91 (see Table 1). When integrated with the AN/TPS-43 radar, the AN/TSQ-91 functions as a major control center for TACS by performing all functions of surveillance and weapons control in its assigned area of tactical responsibility. Two modes of operation are possible: computer assisted, in which the HM 4118 computer processes surveillance data, computes weapons data and generates displays; and manual, in which surveillance and weapons control are accomplished by operations personnel utilizing raw video data and manual techniques.

TABLE 1. AN/TSQ-91 DEPLOYMENT CONFIGURATIONS

Item	Configuration		
	Min.	Med.	Max.
Modules			
Group Display Module	1	2	3
Console Module	1	2	3
Air Conditioning Module	1	2	2
Ancillary Equipment Module	1	1	1
Data Processing Module	1	1	1
	5	8	10

Table 1. (con't)

Item	Configuration Min.	Med.	Max.
Module Contents			
Video Mapper	3	3	3
SIF Processor	1	1	1
Group Displays	1	2	3
Display Stations	6	10	14
Operational Positions	15	27	55

1.1.2.2 3-D Radar (AN/TPS-43). The AN/TPS-43 is a lightweight, air transportable, three dimensional radar which provides search, height and IFF/SIF/AIMS data to the CRC/CRP Operations Centers. It consists of an equipment shelter and an antenna pallet. The AN/TPS-43 is manufactured by Westinghouse. Its performance characteristics are:

Frequency	-	2900-3100 MHz
Peak Power Output	-	2.8 MW
Pulse Width	-	6.7 μs (phase coded)
Pulse Repetition	-	250 PPS
Antenna	-	6 Beams
	-	Azimuth beam width 1.1 degrees
	-	Elevation beam width 1.7 degrees
	-	Scan Rate 6RPM
	-	Aperture 14 x 22 feet
Height	-	Readout - digital
	-	Accuracy ± 2000
3-D Coverage	-	Consistent through 360 degrees
	-	Maximum Altitude 75,000 feet
	-	Range 100 to 200 nautical miles
IFF/SIF Interrogator	-	AN/TPX-47

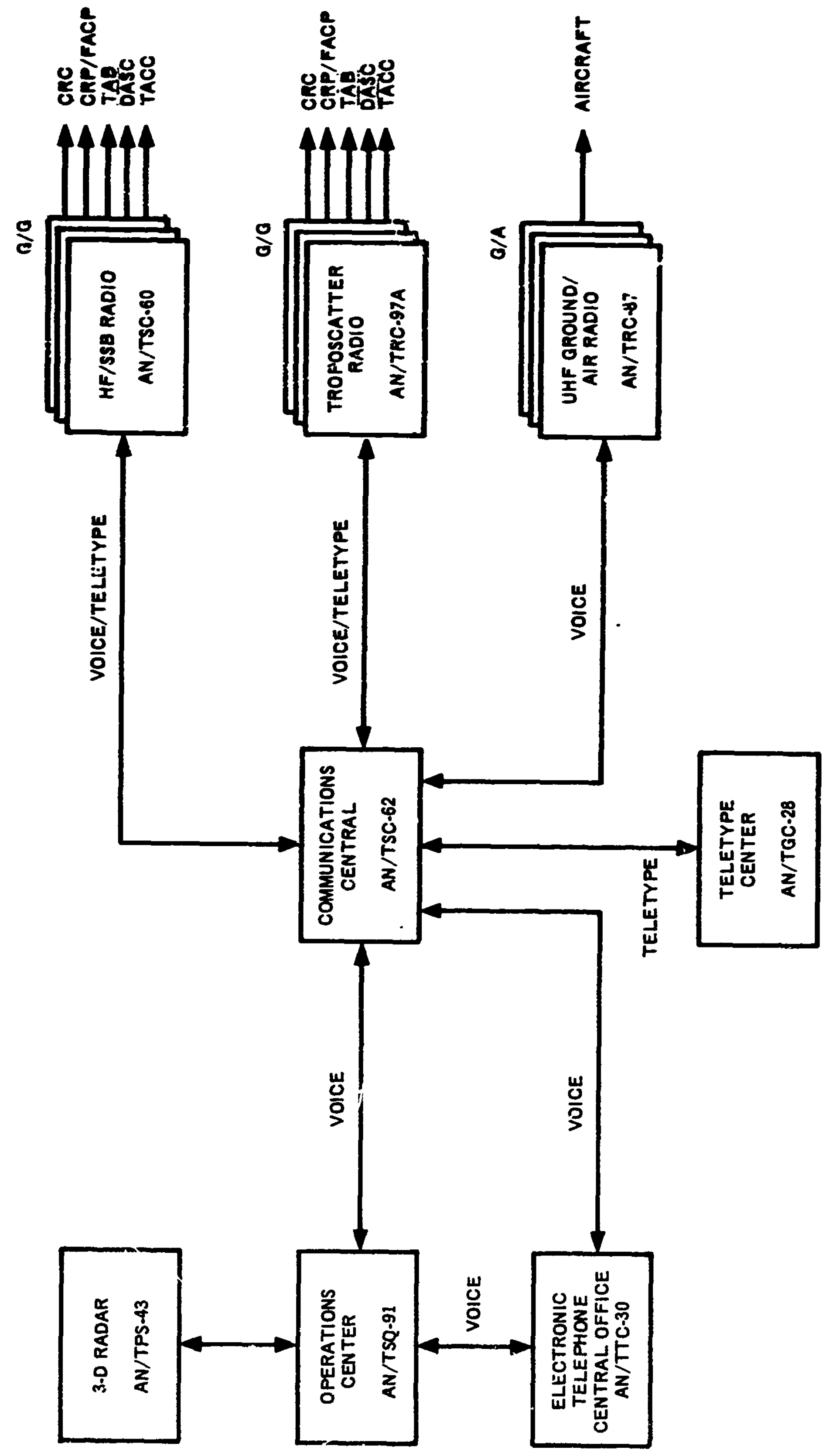

Figure 3. CRC/ATRC Equipment Diagram (Typical)

1.1.3 Control and Reporting Post Element (CRP)

The Control and Reporting Post is an element/operating location subordinate to the CRC and provides radar control and surveillance within an assigned area forward of the CRC. Thus, it extends the control and surveillance/warning area coverage of the CRC. The CRP has the capability of assuming CRC functional responsibilities in an emergency. One or more CRP's may be utilized depending upon area size, terrain conditions, and anticipated level of air operations. In its assigned capacity, it provides the operational link between CRC and FACP elements. Its capabilities are identical to those of the CRC but its functions are subordinate (e.g. identification and weapons assignment are centralized in the CRC).

The CRP will normally forward-tell filtered track information developed internally and from subordinate FACP's to the CRC. Internally, the CRP provides navigational assistance and direction to aircraft on offensive and defensive missions. To perform these functions, the CRP maintains communications with the CRC, adjacent CRP's, subordinate FACP's, and the TAB's for which it has been authorized scramble authority. Normally, the CRP contains sufficient air movement/identification and IFF/SIF (Identification-Friend-Foe/Selected Identification Features) capability to assume the CRC "manager" functions of the aircraft control and warning network, if tactically required.

The equipment and facilities available at the CRP are identical to those at the CRC. The expansion capabilities are also identical. For a description of these, refer to paragraph 1.2. Typical equipment configuration for the CRP is shown in Figure 4.

1.1.4 Forward Air Control Post Element (FACP)

The FACP is a mobile radar and communication (control) element normally subordinate to a CRP. It augments the CRC and CRP surveillance coverage within the forward combat area. The FACP is primarily responsible for radar control of

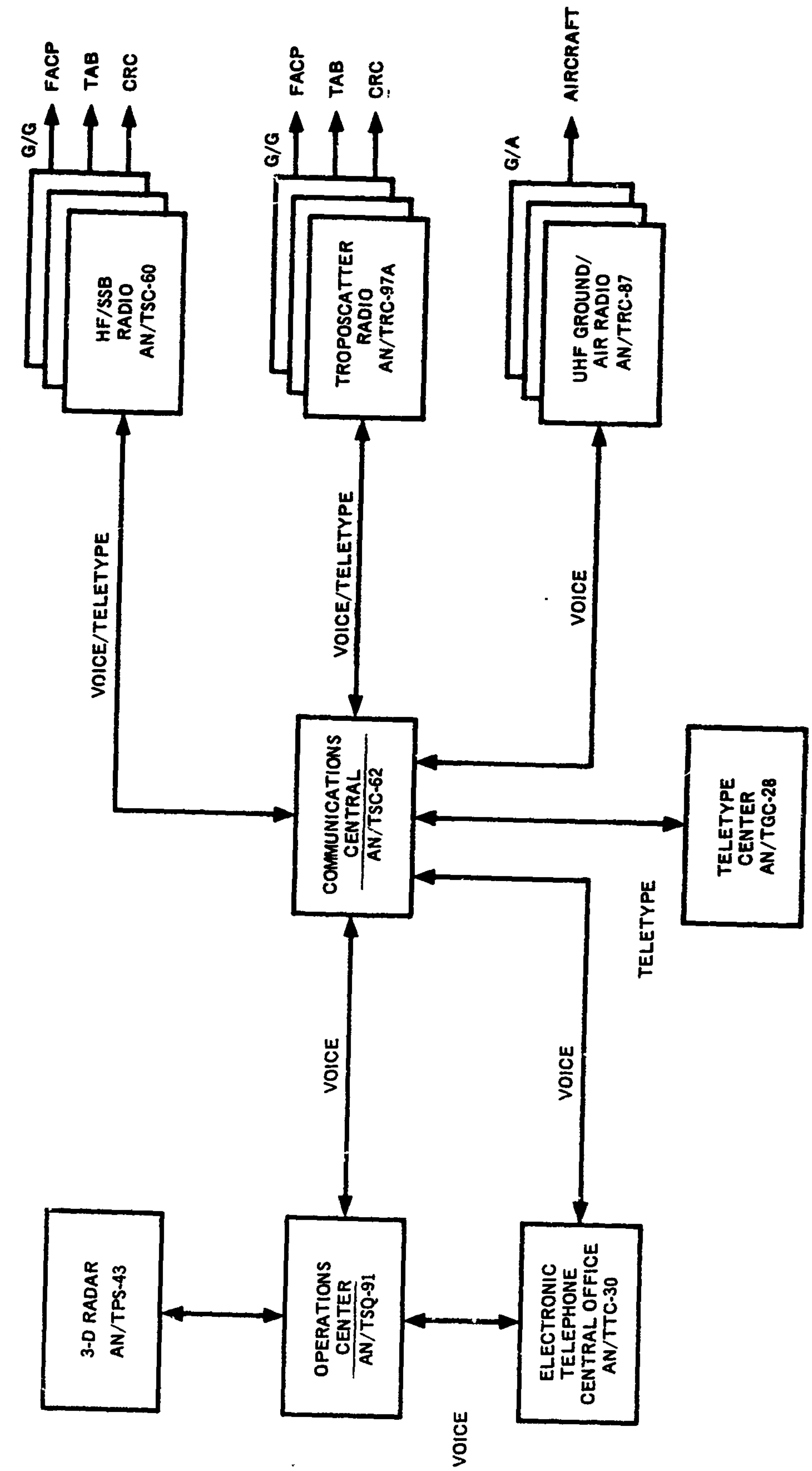

Figure 4. CRP Equipment Diagram (Typical)

missions to and from designated control points for hand-off to Forward Air Controllers (FAC) directing close air support missions. It operates in the forward battle area and is capable of positive control of tactical missions during marginal and instrument flight rules (IFR) conditions down to an altitude of 1000 feet (above ground level) within a radius of 30 miles. The element is self-contained and does not require the large communications centers provided for other elements. The FACP is a single configuration element and is provided an integrated communications center, an operations center, and associated radar and radio sets.

The FACP may function alone, in the initial phase of a TACS deployment, to provide the preliminary air control and surveillance capability pending follow-on positioning of CRC's and CRP's. As part of a more complete deployment, the FACP provides low altitude or gap filler coverage and control and/or navigational assistance to aircraft on offensive and defensive missions. More than one FACP may report to a single CRP; and in instances where CRP's have not been deployed in the area, they may report to the CRC. Typical equipment configuration for the FACP is shown in Figure 5.

1.1.4.1 Operations Center (AN/TSQ-61). The AN/TSQ-61, when integrated with the other equipment (i.e., radar, IFF/SIF, and communications equipment), performs the functions of surveillance, identification, control of aircraft, and information processing. The Operations Center is a one-shelter module which provides space and facilities for four operator positions. The center contains two tracking and aircraft control display consoles, plotting boards, remote video control for the AN/TPS-44, IFF/SIF decode and control equipment, secure telephone and associated ciphony equipment, and non-secure telephone and interconsole communications equipment.

1.1.4.2 2-D Radar (AN/TPS-44). The set is an air transportable, two-dimension surveillance radar which provides both radar and SIF capability. It consists of an equipment shelter and an antenna pallet. The AN/TPS-44 is manufactured by Cardion Electronics. Its performance characteristics are:

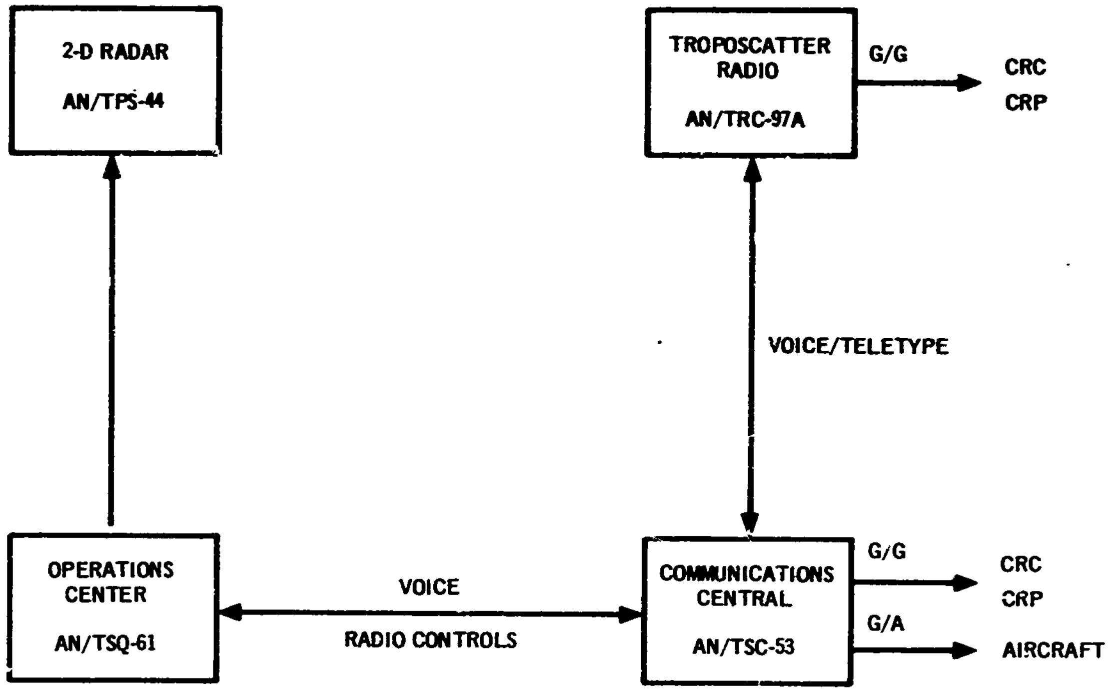

Figure 5. FACP Equipment Diagram (Typical)

Frequency	-	1250-1350 MHz
Peak Power Output	-	1 MW
Pulse Width and Pulse Repetition Rates	-	Short Range (40 NM - 80 NM) 1.4 μs 800 PPS
	-	Medium Range (120 NM) 1.4 μs 533 PPS
	-	Long Range (275 NM) 4.2 μs 267 PPS
Antenna Beam Width	-	Horizontal 4 degrees
	-	Vertical 8 degrees
Antenna Revolutions	-	Variable 0-15 RPM, 360°
IFF/SIF Interrogator	-	AN/TPX-48

1.1.4.3 Communications Central (AN/TSC-53). The AN/TSC-53 is provided at the FACP for voice and teletype communication. The central provides an inter- and intrasite telephone facility, required radio sets for point-to-point and ground-to-air communications (with other sites and airborne aircraft) and a facility for monitoring, testing, and patching all equipment and circuits.

1.2 TACTICAL AIR SUPPORT SUBSYSTEM (TAS)

1.2.1 Direct Air Support Center Element (DASC)

The DASC is a highly mobile air transportable facility designed to operate with the Army Tactical Operation Center (TOC). It is subordinate to the TACC and receives plans and coordinates Army requests for immediate close air support, tactical air reconnaissance, and assault airlift. It directs the employment of the air effort allocated for these missions and acts as advisory agency to the Army Commander on the feasibility of requests for air support. The DASC also provides overall supervision for the activities of the Tactical Air Control Parties (TACP's). It is capable of rapid deployment and has mobility sufficient to permit operation under field conditions including the ability to split its facilities and personnel in a "leap-frog" fashion to insure continuous operation when changing location.

The highest ground force level conducting combat operations will be provided a DASC. The size of a DASC deployment is dependent primarily upon the force level supported, which can vary from a single division (or smaller operation) to a Field Army. Typical equipment configuration for the DASC is shown in Figure 6.

1.2.1.1 DASC Operations Center (AN/TSQ-93). The center is the operations/communications portion of the DASC which is integrated with the Army Tactical Operations Center to provide fast reaction to ground requirements for immediate close air support and tactical reconnaissance. The operations/communications modules (inflatable shelters) are capable of expanding from an alternate through a maximum configuration. The number and types of modules for each deployment configuration are listed in Table 2.

TABLE 2. DASC MODULES

Item	Alt.	Min.	Med.	Max.
DASC Operations Module	1	1	2	3
DASC Communications Module	0	1	1	1
Prime Power/Air Conditioning Module	1	2	3	4
Total	2	4	6	8
Desk Positions, Communications and Support Equipment for Following Number of Personnel	12	10	24	36

The operations module will normally be mated (electrically and physically) to the communications module. The operations shelter will contain radio and telephone patching equipment through which the operational positions are provided secure and nonsecure telephone and ground-to-air radio service. The module will also be provided with display boards for plotting and posting tactical situations.

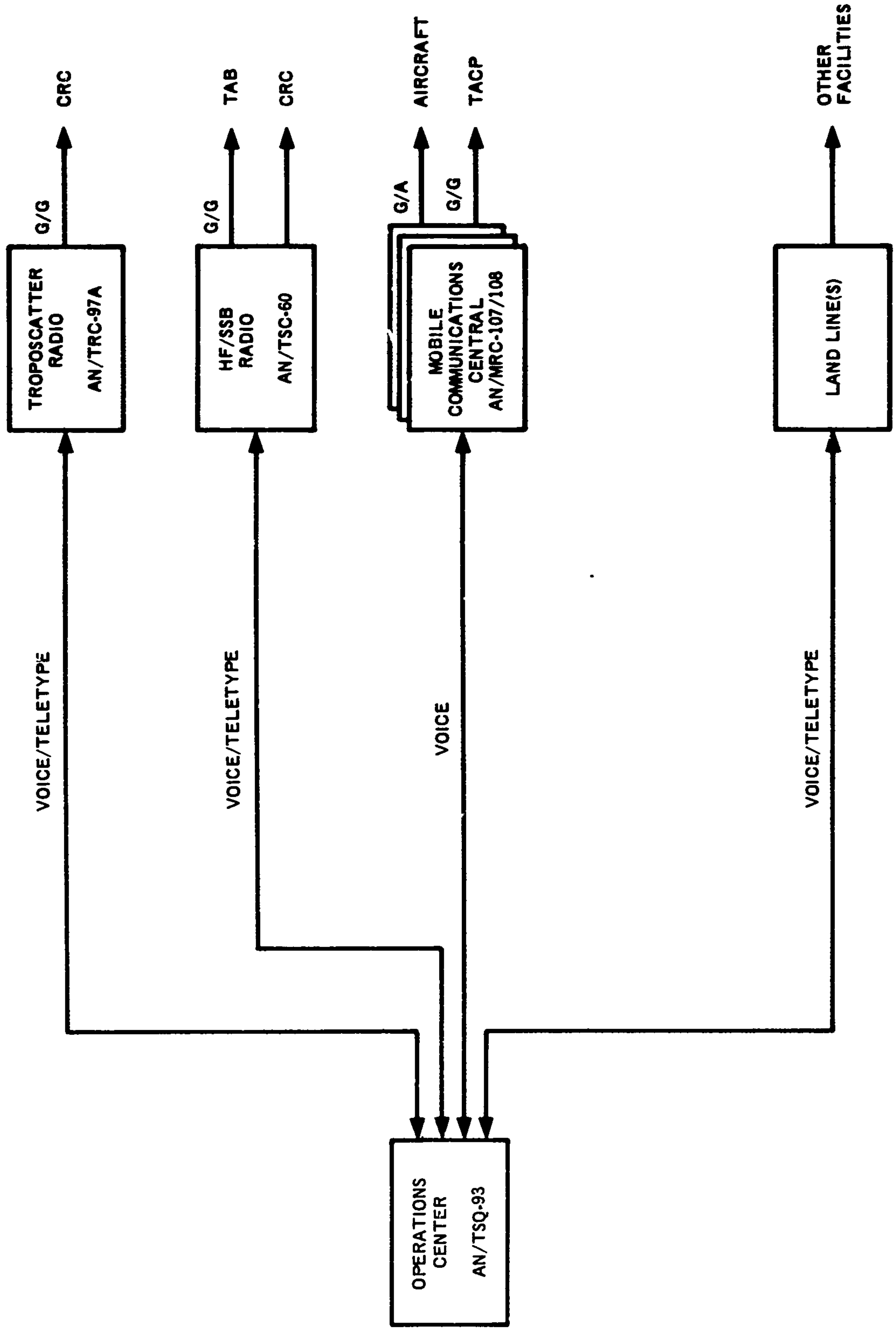

Figure 6. DASC Equipment Diagram (Typical)

The communications module is used to accomplish interconnection of the transmission media to the operations module. It provides telephone switching, secure and nonsecure teletype and telephone communications, and technical control capability.

1.2.1.2 Mobile Communications Central (AN/MRC-107/108). The AN/MRC-107 and AN/MRC-108 are vehicle (M-151) mounted communication systems which operate in HF, VHF and UHF ranges. They provide communication between the AN/TSQ-93 and TACP's and/or aircraft.

1.2.2 Tactical Air Control Party Element (TACP)

The TACP consists of Air Force personnel and mobile communications equipment. The personnel are "attached" to Army command posts (CP) as Air Liaison Officers (ALO) and in the front lines as Forward Air Controllers (FAC). The FAC visually directs tactical air strikes on ground targets close to friendly lines. The ALO at the CP normally serves to advise the Battalion Commander of Air Force capabilities and also transmits mission requests to the DASC. Typical equipment configuration for the TACP is shown in Figure 7.

1.2.2.1 Manpack Radio Equipment (AN/PRC-66). The AN/PRC-66 is a UHF/AM radio set, weighing less than 20 pounds, used by forward personnel for ground-to-air communications. The AN/PRC-66 replaces the AN/PRC-41 (UHF/AM).

1.2.2.2 Manpack Radio Equipment (AN/PRC-74). Data are not available on the AN/PRC-74. It will replace the AN/PRC-47 (HF/SSB) which is a two-man manpack radio used for communication between the Forward Air Controller and DASC operations.

1.3 AIR TRAFFIC CONTROL SUBSYSTEM (ATC)

1.3.1 Air Traffic Regulation Center (ATRC)

The ATRC is collocated with, and is an integral part of, the CRC/CRP. It is responsible for the control of all airborne aircraft within the CRC's area of

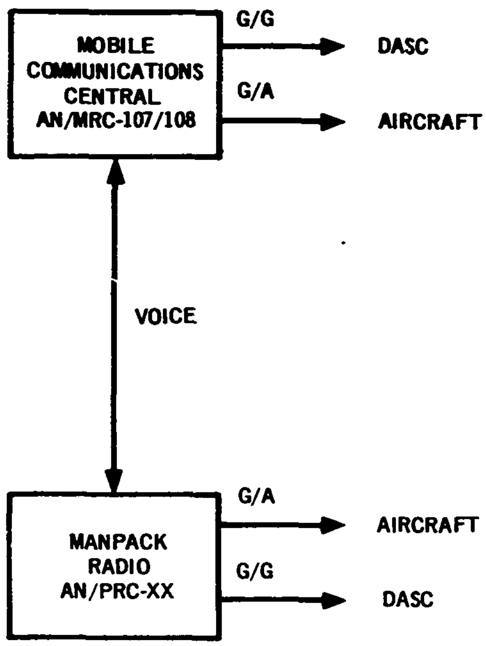

Figure 7. TACP Equipment Diagram (Typical)

operations except those departing/arriving a Tactical Air Base and those actively involved in combat missions. It provides air traffic coordination between all military and civilian aircraft. The ATRC utilizes equipment already described as part of the CRC complex and is allocated one (minimum and medium configurations) or two (maximum configuration) consoles in the AN/TSQ-91 for use by the Air Traffic Controllers.

1.3.2 Terminal Air Traffic Control Facilities (TATCF)

The TATCF are transportable, mobile facilities responsible for the safe and expeditious flow of arriving or departing aircraft into and out of air bases. The facilities provide guidance for the control of arriving or departing aircraft through the use of a control tower, surveillance radar, precision approach radar, terminal navigational aids (TACAN, VOR, radio beacon, etc.) and UHF/VHF direction finding equipment.

The configuration of equipment is dependent on the size of forces being supported and the availability of existing equipment at the air base. Typical equipment configuration for the TATCF is shown in Figure 8.

1.3.2.1 Landing Control Central (AN/TPN-19). The AN/TPN-19 is a transportable, self-contained complex capable of operating as a Ground Control Approach (GCA) or Radar Approach Control (RAPCON) facility. It is capable of simultaneously performing surveillance and precision GCA functions for terminal air traffic control and approach guidance assistance for landing all types of aircraft. As an operations center, it is the heart of the TATCF.

Included in the AN/TPN-19 complex are Precision Approach Radars (PAR) and Airport Surveillance Radars (ASR) which are linked by microwave to the AN/TPN-19 operations center. The radars are manufactured by Raytheon. The performance characteristics are:

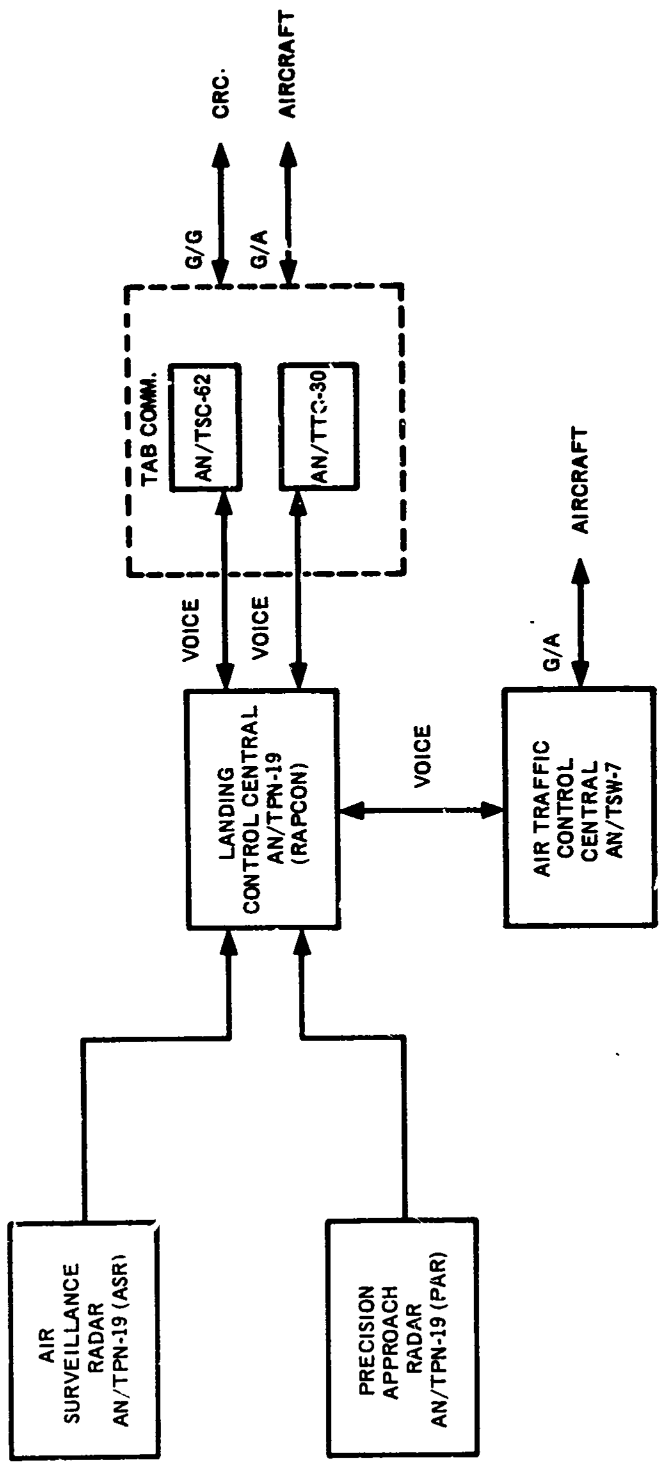

Figure 8. TATCF Equipment Diagram (Typical)

PAR System

Clear Weather Range	-	20 NM
Target in Rainstorm Range	-	14.7 NM
Minimum Range	-	600 feet
Elevation Coverage	-	14 degrees
Azimuth Coverage	-	20 degrees
Elevation Accuracy	-	8 feet (6000 feet from radar)
Azimuth Accuracy	-	15 feet (6000 feet from radar)
Transmitting Power	-	1000 W

ASR System

Clear Weather Range	-	100 NM
Adverse Weather Range	-	60-100 NM
Minimum Range	-	.5 NM
Elevation Coverage	-	0-30 degrees
Range Resolution	-	500 feet
Azimuth Resolution	-	2 degrees
Azimuth Accuracy	-	± 1 degree
Transmitting Power	-	547 W

1.3.2.2 Air Traffic Control Central (AN/TSW-7). The AN/TSW-7 is a transportable control tower facility with VHF and UHF G/A capabilities linked to the AN/TPN-19. It is used to perform local control, ground control, and transmission of flight data within the vicinity of the tactical air base. It can be extended vertically to a maximum of 4 feet.

1.4 COMMAND COMMUNICATIONS SUBSYSTEM

1.4.1 AFCCP/TACC Communications

Communications equipment previously described as part of the AFCCP/TACC complex is utilized by the Air Force Component Commander for the Command Communications Subsystem. No additional equipment is required at the facility to support this function.

1.4.2 Tactical Air Base (TAB) Communications

TAB Communications is a transportable facility which consists of telephone, teletype and radio equipment. In addition to providing intrabase communications, it is also considered an integral part of the Command Communications Subsystem. Typical equipment configuration for a TAB is shown in Figure 9. The equipment has previously been described.

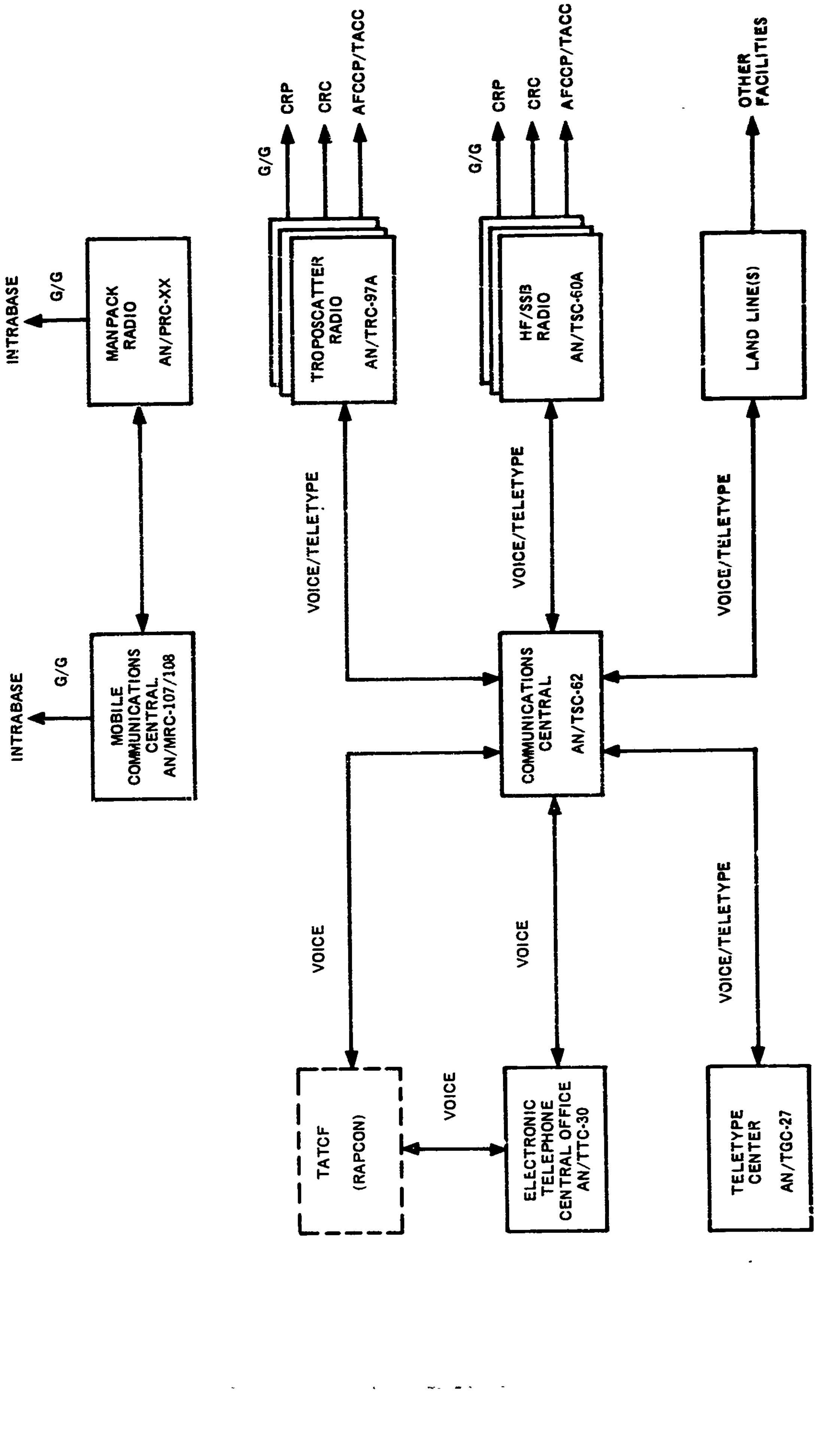

Figure 9. TAB Equipment Diagram (Typical)

SECTION 2. AN/TSQ-91 (CRC)

TACS is based on the principles of centralized control and decentralized execution, with all efforts fully coordinated. The TACC, as the operations center for the Air Force Component Commander (AFCC), provides centralized control; the CRC, DASC, CRP, TACP, and FACP provide decentralized execution; and the communications network of TACS provides the AFCC with the ability to ensure rapid coordination of effort.

The CRC is the first subordinate level of TACS. It coordinates the radar surveillance and aircraft control activities of TACS and furnishes air situation information to the TACC and DASC. It controls and directs the overall air defense effort, air traffic, and tactical missions within its designated geographic area. The CRC performs these functions with the support of a CRP(s) and an FACP(s). The operations center for the CRC is the AN/TSQ-91.

This section contains a detailed description of AN/TSQ-91 equipment and system operations, and a functional description of the CRC.

2.1 AN/TSQ-91 MODULES AND EQUIPMENT

Performance of the CRC's tasks in the various environments that may be anticipated requires that shelters be provided which are lightweight, easily transportable, need little set-up/tear-down time, and are modular enough to allow for adjustment to varying deployment requirements. These requirements have led to development of transport packages (modules) which can be joined together to form operations centers of varying size. The modules are S-280 type shelters, modified for use as deployable shelters. Depending on the needs of a given deployment, the CRC operations center (AN/TSQ-91) will be made up of a subset of the following:

- Group Display Module (GDM)
- Console Module (CM)

- Data Processing Module (DPM)
- Ancillary Equipment Module (AEM)
- Radar Remoting Module (RRM)
- Air Conditioning Module (ACM)

The Group Display and Console modules are joined together to form a single operations room which houses operations personnel, consoles, group displays and communications equipment. To this basic complex is added an Ancillary Equipment Module and a Data Processing Module. These latter two modules contain two additional consoles, the HM-4118 computer and associated peripheral equipment, video mapping equipment, and status and control panels. If a radar is collocated with the CRC, radar video and control information is received at the CRC via direct coaxial cable; otherwise, a Radar Remoting Module is employed to receive radar data from the radar site. The radar information is distributed by video distribution equipment to all consoles. See Figures 10 and 11.

Two modes of operation are possible: computer-assisted, in which the HM-4118 computer processes data and generates displays on the consoles; and manual, in which the consoles receive data only from the radar. In the computer-assisted mode of operation, assigned personnel monitor their consoles to perform the functions of aircraft detection, acquisition and tracking. Console switches are used to enter track and other information into the computer. The computer stores information; performs the computations needed for rate-aided manually initiated tracking (RAMIT) or automatic SIF tracking; displays data in the form of coded symbols and alphanumeric data; and performs calculations needed in the control of assigned weapons. Console operators also pass track information by voice to plotters, who place it on the manual plot board for group viewing.

The consoles and communications equipment are utilized by Weapons Section personnel who commit and control aircraft on required missions. A defensive

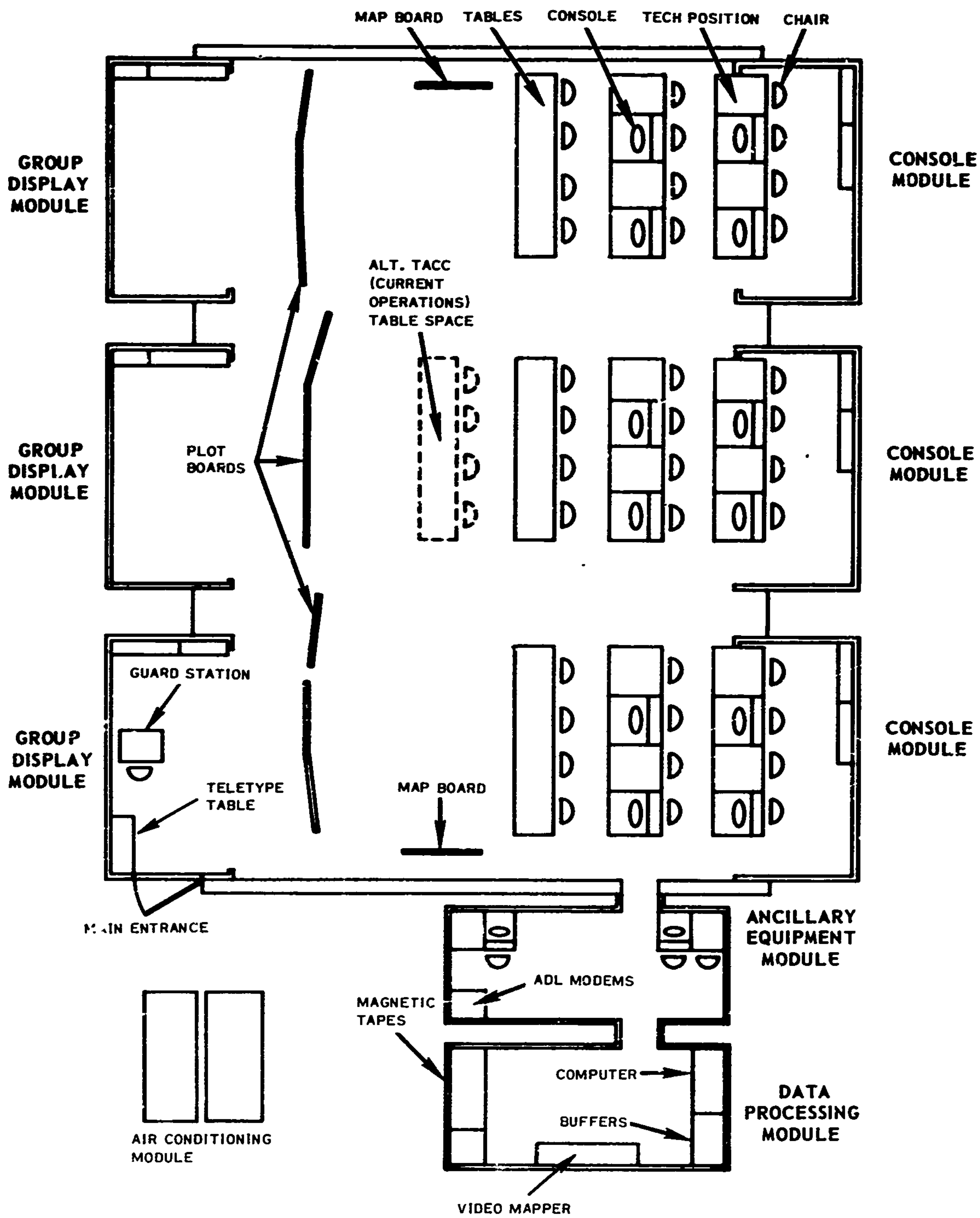

Figure 10. Maximum Deployment Layout

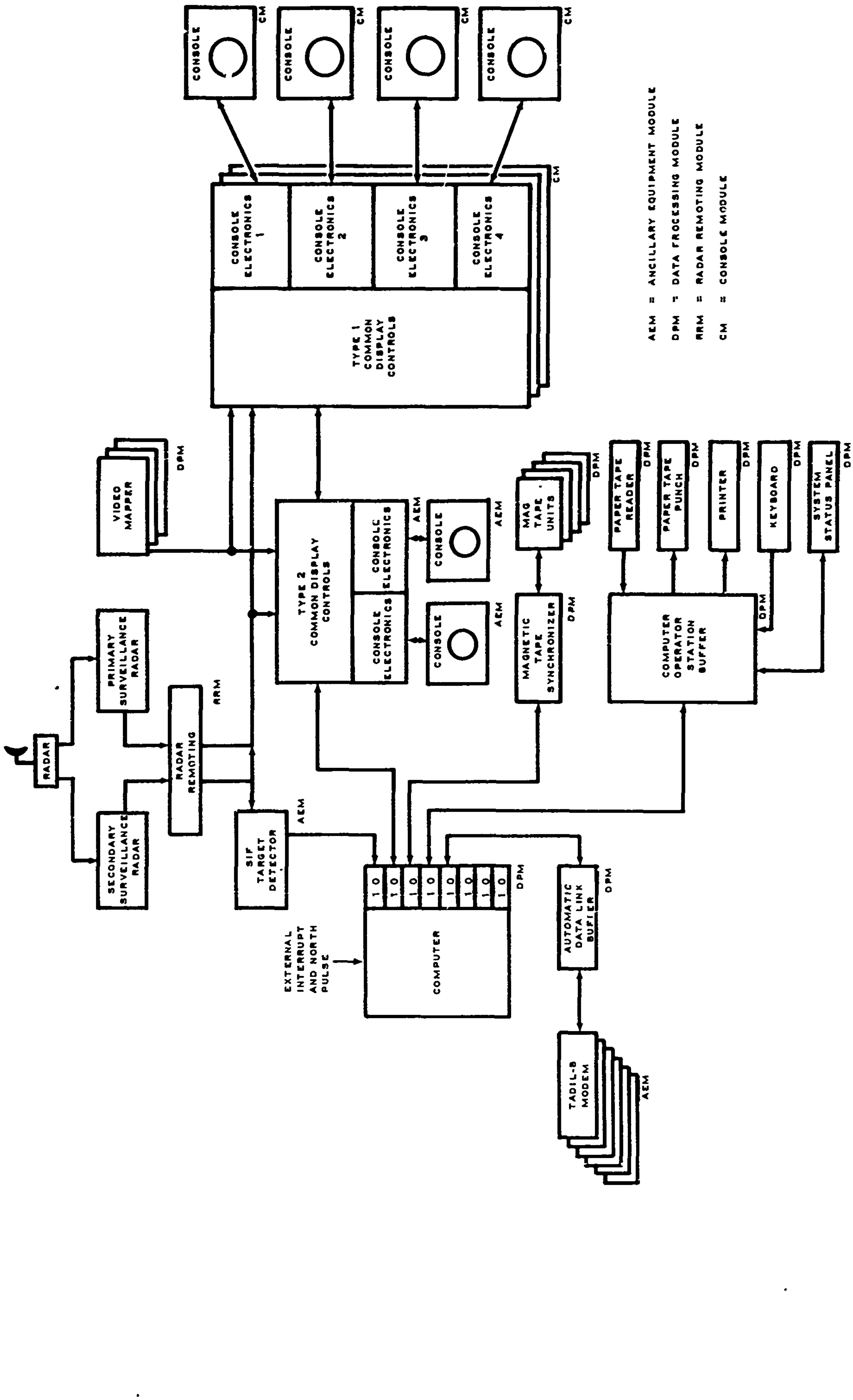

Figure 11. Data Processing Configuration

mission may be passed to Surface-to-Air Missile (SAM) batteries through an Army Air Defense Command Post (AADCP); or the mission may be handled by an air-to-air interception mission controlled by Weapons Section personnel. Target and fighter information are entered into the computer by console action and guidance calculations are computed and presented on the weapons consoles. Weapons Section personnel pass control information to the aircraft pilot by means of voice ground-to-air communications equipment.

Movements and Identification personnel identify tracks, primarily by flight plan correlation, and enter track identification information into the computer by console action.

Air traffic control personnel regulate and control air traffic through the CRC area of responsibility, utilizing the console and communications equipment.

Console operators are provided with video map and background displays to assist in the control of aircraft. Weather information is received on the weather teletype via the communications facilities and is entered into the computer by the computer operator.

Tracks of interest to other operations centers or agencies, and tracks requiring handover to other stations, either are transmitted via data link or voice-told by tellers.

The Console, Ancillary Equipment, and Data Processing modules are discussed in greater detail in the following paragraphs.

2.1.1 Console Module and Group Display Module

The operations room, formed by combining a Group Display module and a Console module, contains four display consoles, each manned by two people--usually an officer and a technician. In addition, a table is provided for four personnel whose functions are either command or liaison. Depending on the required AN/TSQ-91 configuration, one, two or three GDM(s) and CM(s) are used to provide

the operations room with 4, 8 or 12 display consoles respectively. One Ancillary Equipment module is attached to the operations room which provides two additional consoles. If the CRC is designated as alternate TACC, four additional table positions are provided.

Major equipment in the GDM includes vertical plotting and display boards, communications equipment and a receive-only teletype for weather information. CM major equipment is discussed below.

TABLE 3. CRC CONFIGURATIONS

Position	Min.	Med.	Max.
Senior Director (SD)		1	1
Air Surveillance Officer (ASO)	1	1	1
Search Scope Operators (SSO)	1	2	3
Movements and Identification (M&I)	1	1	1
Weapons Assignment Officer (WAO)		1	1
Air Weapons Controllers (AWC)	2	2	3
Air Traffic Controllers (ATC)	1	1	2
Air Defense Artillery Liaison Officer (ADALO)		1	1
Spare Console			1

2.1.1.1 Common Display Controls (CDC). The Console module contains a Type 1 CDC, composed of five major elements which provide data to display consoles. The elements consist of one Data Distribution Group (DDG) and four Console Electronics (CE).

The DDG accepts radar data, SIF data, video map data, and display buffer data and converts them into a form acceptable by the CE's, then distributes them to the proper CE. The DDG receives display console inputs via CE's and prepares them for transmission to the display buffer. It also provides controls for sweep simulation as part of a self-test capability.

Each CE is assigned to a specific console, and provides the proper deflection and intensity for the displays being presented on the plan position indicator (PPI) and auxiliary read-out display (ARO).

The DDG and CE's can be operated independently of the computer to provide a limited display capability in the manual mode (e.g., track ball tab, gate, cursor, etc.).

Each Console module will contain a CDC to drive its four display consoles, resulting in a maximum of three Type 1 CDC's in the AN/TSQ-91.

2.1.1.2 Display Console. Lightweight design requirements have resulted in a 300-pound display console which contains a 16-inch and a 7-inch cathode ray tube used to display radar video and computer generated symbology; a high voltage power supply; several control panels; and some of the display electronics. The console is 43 inches high, 33 inches wide, and 35 1/2 inches deep. Display consoles are multifunctional and may be used interchangeably. See Figure 12.

In the manual mode (without computer assistance), the console generates a cathode ray tube display of range marks and radar, SIF, and map videos. In addition, the following manual mode capabilities are available:

- Range scale and offset selection of the display
- Active and passive SIF decoding
- Range and bearing cursor operation
- Height operations
- Radio and telephone communications

In the computer assisted mode, the console can be operated in any one of nine modes: seven positional modes; one manual mode; and one test mode. The seven positional modes are:

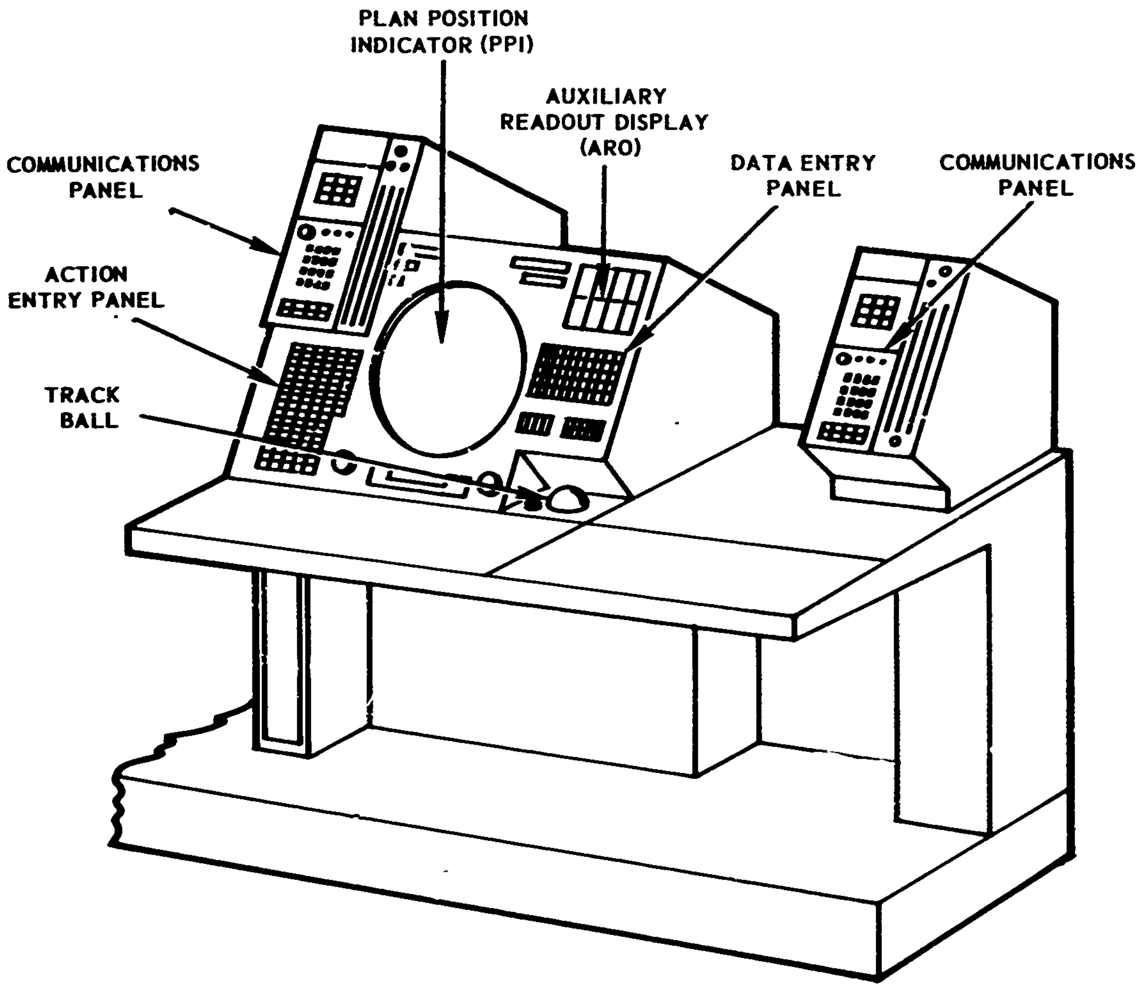

Figure 12. The Console

Search Scope Operator

Air Surveillance Officer

Movements and Identification

Senior Director

Weapons Assignment Officer

Weapons Director/Air Traffic Controller

Air Defense Artillery Liaison Officer

When operated in any of the positional modes all manual capabilities, plus display of track information, intercept vectoring data and geographic data are available. The console can present the total computer display load within less than one second. This total display load consists of: track messages, each containing a track symbol, up to 15 alphanumerics, and a velocity vector; offset/intercept points; other fixed points/track alerts; geographic segments; and mission geometry lines.

The console test mode enables a console operator to determine the operational status of the console and its support equipment. Activation of the test mode results in the display of the PPI and ARO test patterns. Also, the test mode provides the operator with the capability to activate switches in the Action Entry Panel or Data Entry Keyboard and observe a corresponding code displayed on the ARO.

The control and displays on the console control panel are as follows:

- <u>The Plan Position Indicator (PPI) Display</u>

  This display presents a plan position of surveillance radar data combined with computer generated data. The presentation includes raw radar video, processed SIF video, video map, track symbols, and amplifying alphanumeric data. These items can be displayed separately or simultaneously. For alarm situations, a blinking message in the display indicates the location and type of alarm. For many alarms, this display is accompanied by an audible alarm.

- Range, Azimuth, Height and SIF Readouts

  These displays present SIF and height data in numeric form, plus certain special symbols associated with the data. Color coding is used to indicate SIF code verification (first digit is green), a blue 5 indicates that the readout is Mode 5/C height, and a blue H indicates the readout is 3-D radar height.

  The displays are arranged on the face of the console above the PPI for quick readability by the operator. These displays are used in both manual and computer assisted operations. See Figure 13.

- Auxiliary Readout (ARO) Display

  This display presents messages from the computer that normally supplement the data on the PPI display; in addition, it supplies category selection data and feedback to the operator in conjunction with the keyboard entry unit. This display can be used only in the computer assisted mode of operation. See Figure 12.

- Data Entry Keyboard

  This panel consists of an alphanumeric keyboard which enables data to be entered in the computer. It can be operated by the console operator/technician in the computer assisted mode of operation. See Figure 14.

- SIF Thumbwheels

  These thumbwheels allow the SIF mode and code to be entered into passive decoding channels for comparison with SIF returns. This device is used in both the manual and computer assisted modes of operation. See Figure 13.

- SIF Enter and Readout Buttons

  These buttons are used to control SIF passive decoding channels. They are used in both the manual and computer assisted modes of operation. See Figure 13.

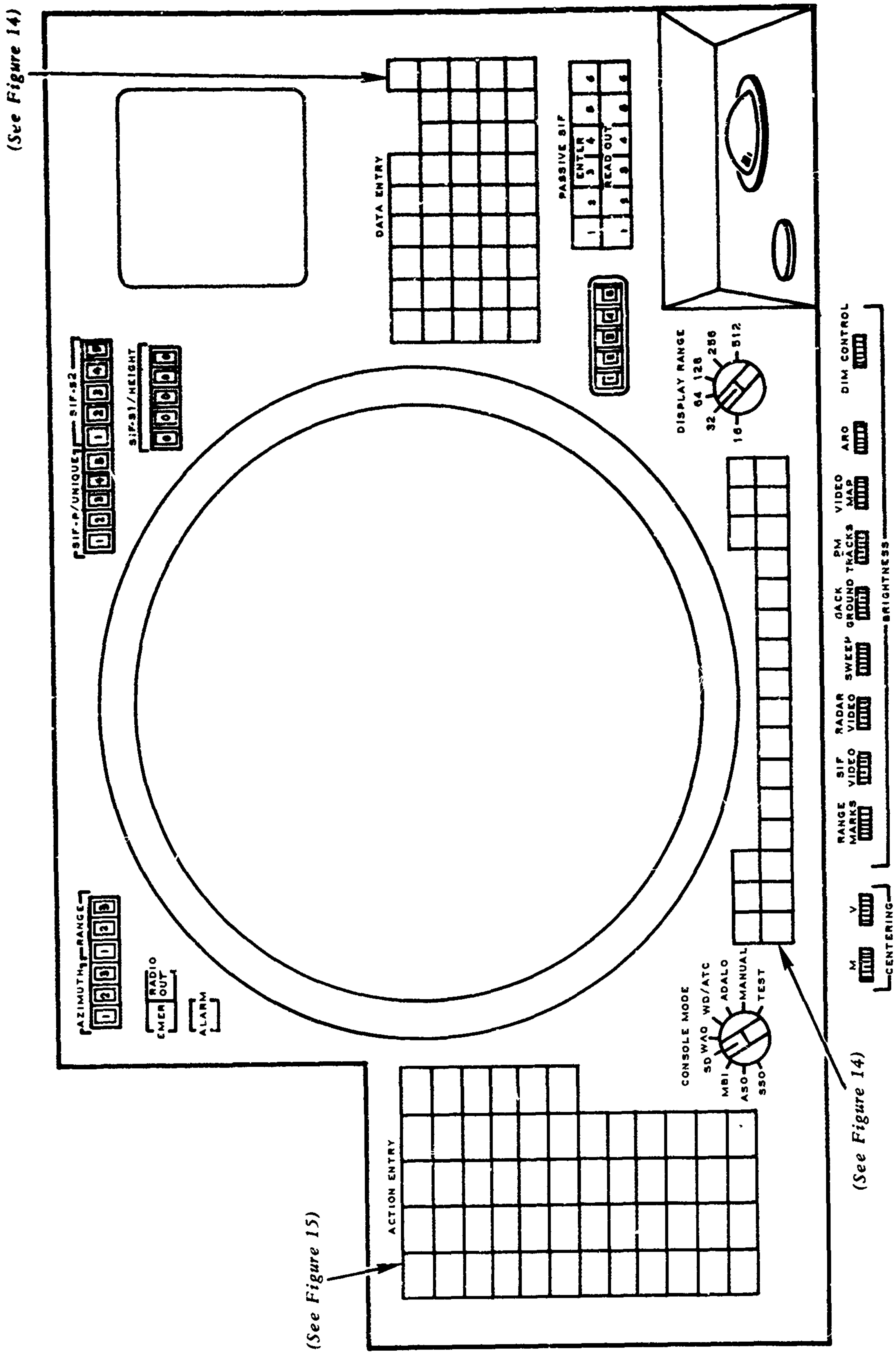

Figure 13. Console Control Panel

A X-TELL TRACK	B MSN/COM STATUS	C ID	D POSITION	E HEADING	F CATEGORY SELECT			TELL SEQUENCE
G DESIG-NATOR	H FLIGHT SIZE	I ALTITUDE	J SPEED	K SIF M + C	L KILLS	1	2	3
M CRUISE SPEED	N CRUISE ALTITUDE	O COMBAT SPEED	P COMBAT ALTITUDE	Q DISPLACE-MENT	R CROSSING ANGLE	4	5	6
S ADA/TELL SUMMARY	T ASSIGN TELL/DL	U REGIST CRITERIA	V INITIATE HANDOVER	W STOP TELL REQ	X REQUEST TELL	7 POINT	8	9
Y TRANSFER	Z TRACK NO. HOOK	SIF HOOK	START TELL	CEASE TELL	BLANK	CLEAR	0 ALERT	ENTER

DATA ENTRY PANEL

VIDEO 1	VIDEO 2	VIDEO 3						VELOCITY LEADERS	SYMBOLS	ALPHA NUMERICS
SIF ANALOG	SIF DIGITAL	MODE 1	MODE 2	MODE 3	MODE 4	MODE 5		VIDEO MAP 1	VIDEO MAP 2	VIDEO MAP 3

VIDEO AND FEATURE SELECT

Figure 14. Display Control

- **Track Ball**

  The track ball is used to reference tracks on the PPI to the computer, offset the sweep origin, establish areas for SIF challenge and height request, and to obtain relative range and azimuth between any two points in cursor operations. The track ball is used in both the manual and computer assisted modes of operation. See Figure 12.

- **Range Switch**

  This switch controls the scale of the PPI display in both the manual and computer assisted modes of operation. See Figure 13.

- **Video Select and Feature Select Buttons**

  These buttons are used to select categories of video and certain features of the track information for display on the PPI. All the video controls are used in the manual and computer assisted modes of operation; the feature select buttons are used only in the computer assisted mode of operation. See Figure 13.

- **Operator Adjustment Controls**

  These controls provide for X and Y centering and the brightness adjustment of range marks, SIF video, sweep, background, PPI tracks, video map, and the ABO. See Figure 13.

- **Console Mode Selector**

  The console mode selector is a nine position rotary switch. The switch selects one of the seven functional positions, a manual mode, or a test mode for the console. Selection of a specific mode disables switch actions not valid for the mission of the operator whose function has been selected. The nine console modes are as follows:

SSO - Search Scope Operator

ASO - Air Surveillance Officer

M&I - Movement and Identification Officer

WAO - Weapons Assignment Officer

WD/ATC - Air Weapons Controller/Air Traffic Controller

ADALO - Air Defense Artillery Liaison Officer

MANUAL - Manual Mode

TEST - Test Mode

See Figure 13.

- Action Entry Panel

  The switches on this panel are used to enter data into the computer and/or to enable display functions. Each console action entry panel contains buttons for all actions accepted by the system, in either manual or computer assisted operation. However, the Console Mode Selector determines which actions will be considered valid for the operator utilizing a specific console. See Figure 15.

- Communications Control Panel

  The switches on this panel link the console operator with the telephone intercommunication and ground-to-air radio system. These controls are used in both manual and computer assisted modes of operation. See Figure 12.

- Emergency Alarm Lamps

  These lamps blink to alert the console operator to emergency SIF codes and to computer generated alarms. The SIF alarms are used in both the manual and computer assisted modes of operation. The computer alarm is used only in the computer assisted mode of operation. See Figure 13.

THESE BUTTONS ARE ALSO AVAILABLE FOR USE DURING MANUAL MODE OPERATIONS (ENTER OFFSET, CURSOR, GATE DISPLAY, HEIGHT REQUEST; OFFSET CENTER, CURSOR LINE, GS8 GS16 GS4 GS2, SIF ACTIVE)

DROP SIM TRACKS / PAIR	ACCEPT SIM TRACKS / CUTOFF	1 OFFSET	2 OFFSET	ENGAGE / COMMAND TRACKING
FRIEND / CANCEL PAIR	FIGHTER / MISSION GEOMETRY	SPECIAL / ENTER FIX POINT	UNKNOWN / CAD ARO	X-RAY / RTB
HOSTILE / CAS	FAKER / CAP	BEE / RENDEZVOUS	YOKE / OFFENSIVE	PENDING / INTERCEPT
ENGAGE WITH B	HOLD FIRE		ENGAGE WITH A	WEAPONS FREE
WEAPONS TIGHT	CEASE ENGAGEMENT			
CANCEL HANDOVER OFF		ENTER MODE	TRACK ARO	ACCEPT HANDOVER/ OFF
		SIM TRACK	MAD ARO	
ENTER OFFSET	CURSOR	GATE DISPLAY	HEIGHT REQUEST	
OFFSET CENTER	CURSOR LINE	GS8 GS16 GS4 GS2	SIF ACTIVE	
DROP TRACK	SPLIT			
AUTO SIF TRACKING	BASE POINT	POSITION ONLY UPDATE	SEQUENCE	
ACKNOWLEDGE	INITIATE	UPDATE	HOOK	

Figure 15. Action Entry Panel

2.1.1.3 Secondary Surveillance Radar* Processor (SSRP). The primary function of the SSRP is to control Selective Identification Feature (SIF) interrogations via the AN/TPX-47 Interrogation Set and process the replies for SIF Modes 1, 2, 3/A, 4 (challenge identification), 5/C (height), and emergency code trains including "May Day" (7700) and "radio out" (7600) codes. The SSRP also senses garbled codes, inhibiting their transmission into the system and performs single sweep defruiting of composite returns for a combination of any three modes except Mode 4.

The SSRP, physically located in the Console module, receives SIF radar returns directly from the AN/TPS-43 radar if the radar is collocated with the AN/TSQ-91, or via a Radar Remoting module if not collocated. SIF returns are transmitted to Digital Display Groups in both the CM and AEM (for display and code readout on the PPI) and to the SIF Processor in the DPM (for track correlation).

The SSRP provides for selection and generation of signals as part of the self-test capability of the system.

2.1.2 Ancillary Equipment Module (AEM)

Additional equipment is required to support the DPM and CM, but would have caused these modules to have exceeded weight and size limitations if included in them. The AEM contains this equipment. One AEM is provided for the AN/TSQ-91 (regardless of configuration) which houses a CDC, two display consoles, a display buffer, two symbol generators, and six full duplex automatic data link (ADL) modems.

2.1.2.1 Common Display Controls (CDC). The AEM CDC is a Type 2 CDC, composed of a Data Distribution Group (DDG) and two Console Electronics (CE). One CE is assigned to each display console in the AEM. The Type 2 CDC is functionally the same as the Type 1 CDC in the Console module, which is described in paragraph 2.1.1.1.

*It should be noted that the term "Secondary Surveillance Radar" applies to the SIF transmitting/receiving device located on the primary search radar antenna, and not to another radar which might be used for backup. The AN/TSQ-91 is not designed to use inputs from two or more radars simultaneously.

2.1.2.2 Display Console. Display consoles in the AEM are identical to those in the Console module (see paragraph 2.1.1.2) and may be used interchangeably.

2.1.2.3 Display Buffer. The display buffer routes display data from the computer to display consoles via the CDC and/or display generators. It also accepts console switch actions via the CDC and transmits them to the computer for processing. One input/output channel is used to service the display buffer which in turn can service up to 14 display consoles. Within one display cycle (approximately 50 milliseconds) the buffer updates all PPI's and ARO's, interrogates all consoles for switch actions, and tests one of the display consoles.

2.1.2.4 Symbol Generators. The AEM houses two symbol generators—one for PPI's and one for ARO's. Their inputs are from the Display Buffer and their outputs are to a data converter in each CDC. There are 64 symbols available for PPI displays and 38 symbols available for ARO displays.

2.1.2.5 TADIL-B Modems. The computer is connected via the ADL buffer to six TADIL-B modems (Tactical Digital Information Link, Type B, modulator/demodulator) contained in the AEM. These modems provide bidirectional, ground-to-ground data link communication between the AN/TSQ-91 and other remotely located facilities. Bit rates can be manually selected at 1200, 600, 300, 150 or 75 bits per second (bps). Since messages consist of 72 bits, approximately 17 messages can be transmitted per second at the 1200 bps rate. Each of the six modems contains an input and an output link, resulting in a maximum input/output transmission rate of over 200 messages per second.

The system is expandable to 10 TADIL-B modems.

Modem outputs may be linked back to input channels to provide a back-to-back test capability, requiring no external signals. Tests may be controlled manually or through computer generated commands via the ADL buffer.

2.1.3 Data Processing Module (DPM)

The DPM contains the HM-4118 computer and its associated peripheral equipment; a video mapper; and an operations station for the computer operator. The DPM is the heart of the AN/TSQ-91's data processing capability. Major components housed in this module are discussed in the following paragraphs and summarized in Table 4.

TABLE 4. HM-4118 CAPABILITIES

Category	Feature	Description
General Computer Characteristics	Operation	Parallel arithmetic
	Logic	Synchronous, 4-MHz clock
	Word Length	18 bits (information) 17 bits (address)
	Instructions	49
	Memory	Five 16,384 word memory modules, 1-μsec cycle time; 81,920 words total capacity; multiple accessing
	Input/Output	1. Parallel data transfer through two buffers with four channels per buffer. 2. SIF processor: 64 completed target reports of six 18-bit words per report/50 milliseconds. 3. Display buffer: 99,940 18-bit words/sec.

Category	Feature	Description
		4. ADL buffer; approximately seventeen 72-character messages/link/second.
		5. Magnetic tape unit: 20,850 6-bit characters/sec., using 7 track tape with 556 bpi density.
		6. Punched tape reader: 200 frames/sec.
		7. Paper tape punch; 40 characters/second.
		8. Printer; 40 characters/sec.
		9. Keyboard; 150 six-character words/minute.
	Number representation	Sign and absolute magnitude (internal). Negative values to the display console are in two's complement form.
	Expansion	Three memory units may be added to expand memory capacity to 131,072 words. Input/output capacity may be increased to a maximum of 16 channels through the addition of processor with memory and/or 8-channel buffered I/O.
Instruction Features	Arithmetic organization	All computation assumes fixed-point binary arithmetic.
	Add, subtract	2 μsec.

Category	Feature	Description
	Double precision add	3.25 or 3.5 µsec.
	Multiply	3.5 µsec.
	Divide	6.25 µsec.
	Square root	9 µsec.
	Gray-code conversion	6 µsec.
Real-time control	External function	2 µsec.
	Elapsed-time clock	Over 2 minutes (1-ms resolution decreasing time) with interrupt capability
	Time-of-day clock	Over 4,772 hours in 2 consecutive memory cells (1-ms resolution increasing time)
	Sense switches	10
	Indicators	10 general purpose (2 not available for use in this system) plus 3 special (overflow, compare high, compare low)
	Memory protect	Memory protected on any ac line transient, with automatic recovery to cell zero
Addressing features	Type of addressing	Single address; direct or relative addressing, with or without index; and/or indirect addressing
	Index registers	48 (4 sets of 12)

2.1.3.1 Computer. The computer is an HM 4118, first produced by Hughes in 1966. It is ruggedized for military use.

2.1.3.1.1 Memory. The computer has a memory capacity of 81,920 18-bit words, but is expandable to 131,072 words by installing eight 16,384-word memory modules instead of the five specified for the AN/TSQ-91 data processing configuration. No auxiliary storage devices (disc, drum) are used other than magnetic tape.

2.1.3.1.2 Processor. The processor is the executive director of the computer. It functions as a coordinator for all other units in executing instructions and performs all arithmetic operations. Functional units within the processor are as follows: program counter; command register; buffer register; accumulator and quotient registers; adder circuits; sense-transfer indicators; interrupt register; and sense switches.

2.1.3.1.3 Buffered Input/Output. The buffered I/O consists of two 4-channel bidirectional buffer units, buffer A and buffer B. (See table 5). The buffers operate independently and establish the priority of data transfer requests for each of their four channels. Maximum data transfer over a single channel is one 18-bit word per 2 microseconds.

TABLE 5. BUFFERED I/O CHANNEL ASSIGNMENTS

Buffer	Channel	Peripheral Unit
A	0	SIF Processor
	1	Display buffer
	2	Magnetic tapes
	3	System status panel
B	4	ADL buffer
	5	Not used
	6	Not used
	7	Operator station buffer

2.1.3.2 Peripheral Equipment and Buffers. All peripheral equipment, except the display buffer and system status panel, interface with the computer via the Peripheral Equipment Buffer (PEB). This equipment consists of: four magnetic tapes, a keyboard/printer/punch (KPP), a punched tape reader, six TADIL-B modems, and the SSRP.

2.1.3.2.1 Magnetic Tape System. The magnetic tape system consists of a magnetic tape synchronizer (MTS) and four magnetic tape units (MTU). The MTS in the PEB provides interface functions between the four MTU's and buffered I/O channel number two in the computer. The MTS will allow data transfer between two MTU's and the computer simultaneously (one read and one write). It provides for parity checks and informs the computer when a tape is busy or not ready, and when a transfer is complete. Magnetic tapes are 10 1/2 inches in diameter with a tape width of 1/2 inch and packing density of 556 characters per inch.

2.1.3.2.2 Operator Station. The operator station provides a means for the computer operator to enter and retrieve information, and to monitor the computer's operation. Station equipment includes: a keyboard and punched tape reader for entering data; a printer and tape punch for retrieving information; and a System Status Panel (SSP) for monitoring computer operations. Except for the latter, this equipment interfaces with the Operator Station Buffer (OSB) located in the PEB. The SSP connects directly to channel number seven of the computer's buffered I/O.

Paper tapes accepted by the reader are 5 and 8 level, at 2/3 inch and 1 inch in width. The punch uses 8 level, 1 inch tape. Printer line length is 72 characters. The SSP provides visual indication of faults occurring in the following equipment: 14 display consoles, computer, display buffer, MTS, OSB, SIF processor, ADL.

2.1.3.2.3 Automatic Data Link (ADL). The ADL buffer in the PEB provides the interface between the TADIL-B modems and the computer. It can handle up to ten input/output channels, providing data sequentially to the computer

through buffered I/O channel number four. Message formats are in accordance with JCS PUB 10 standards.

2.1.3.2.4 Selective Identification Feature Processor (SIFP). The SIFP accepts returns from the SSRP and correlates them to determine the location of valid targets. It contains its own memory in which information on a maximum of 64 targets is accumulated. Each target report consists of six words: range, leading edge azimuth, trailing edge azimuth, primary SIF code, first secondary SIF code, and second secondary SIF code. Correlation is determined by the number of returns detected at a given range and azimuth, reporting the same SIF mode and code. The azimuth beam width is manually selected at the SIFP control panel. The computer then uses this information to update track information in memory, and to smooth and predict positions of tracks on Automatic SIF Tracking.

2.1.3.3 Video Mapper. The video mappers are not part of the data processing system and are, therefore, available during manual operations. There are three mappers in the DPM, and console operators may select any combination of their outputs. Maps can be prepared for the video mapper on site within thirty minutes and mounted in the scanning unit in less than five minutes. The map scanners are synchronized with the radar sweep by means of three video map sweep units physically located in the AEM.

It should be noted that a limited map drawing capability exists within the computer, allowing console operators to generate up to 20 line segments to depict such temporary features as Forward Edge of Battle Area (FEBA), enemy concentrations, anticipated attack zones, etc. These may be assigned to one of the three video map selection categories so that they will appear on the operator's scope when that video map category is selected.

2.2 SYSTEM OPERATION

The AN/TSQ-91 is a system built around the concepts of a manual CRC. Automation has been applied to enhance the CRC's operation and to expand its capability,

but because of the extensive manual capability underlying the system, operating in a manual mode (without computer assistance) does not appear to seriously degrade the AN/TSQ-91's operation.* Within the restriction that a single radar imposes on the system, total reliability may, therefore, be assumed to be good. The following paragraphs will not deal with manual operations, however, since, from the Army's point of view, interface with the AN/TSQ-91 under manual conditions will be available only through voice communications.

The CRC is the principle point of interface for most agencies dealing with TACS since it is the highest element with an automated capability. The AN/TSQ-91 will be capable of communicating with Army (AN/TSQ-73), Navy (NTDS), Marine (MACCS), and other systems when the AN/TSQ-91 becomes operational. Since data link will be the prime means of communication between these systems, message content and formats must be universal, and each system must be capable of interpreting them. Joint service discussions are currently under way to accomplish this; therefore, ADL capabilities will only be reviewed in general terms in this section.

The system used in the HM 4118 computer to conduct operations for the CRC is the Operational and Recording Program (ORP). Its functions are the subject of the following paragraphs. The second system, Simulation and Data Reduction Program (SDRP), is designed primarily to aid in program test and fault isolation and will be discussed briefly. The third system, Utility Program (UP), will only be mentioned since its function is one of program assembly and debugging.

The switch actions, displays, and alarms available to operators are extensive and will predictably undergo modification before the system becomes operational. They will, therefore, be discussed only where specific ones assist in explaining system functions more fully. Alarms are forced when conditions warrant immediate action by an operator and are usually accompanied by a display elaborating on the conditions. Other displays are requestable by operators desiring information on the air situation, a specific aircraft, data link lines, console status,

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*Since the system has not yet been used operationally, this assumption is based on the concept of system operation in both manual and computer assisted modes as described in the documentation reviewed.

aircraft mission geometry, etc. In addition to the PPI, digital information is available via the Auxiliary Readout (ARO) display. Switch actions are generally used to request information (displays) or to enter data into the computer for use by various functions in their processing. The system will inform the operator if he has taken an action considered illegal for his position or if inserted values exceed parameter limitations.

2.2.1 Radar Inputs

Radar returns may be separated into two categories: (1) those which are a result of radio impulses reflecting off an object (aircraft); and (2) those which are from an aircraft transponder, triggered by a pulse from the radar antenna. The latter are IFF/SIF/AIMS radar returns and will be referred to as "SIF data" for the ensuing discussion, while the former category will be referred to as "search data."

2.2.1.1 Search Radar Data. Search data received from the AN/TPS-43, either directly by cable or via a Radar Remoting module, are entered into Data Display Group equipment in the Console and Ancillary modules. The data are converted for display and then routed to PPI's. Since search data do not enter the computer at any time, they cannot be used for automatically tracking target aircraft. The display console operator manually alters positions of tracks carried by the computer as he monitors search data trails on the scope. (This will be discussed further in the paragraph on RAMIT tracking.) Should the computer system malfunction, operators can continue to perform monitoring and tracking functions necessary to maintain a picture of the air situation by employing techniques used in existing manual systems.

2.2.1.2 SIF Radar Data. The transmission of SIF codes from an aircraft transponder is triggered by coded signals from a SIF transmitter located on the ground radar antenna. The transponder will respond with a SIF code in the same mode (1, 2, 3A, 4 or 5/C*) as the triggering pulse from the SIF transmitter. The exceptions are emergency codes which respond to any trigger pulse. To ensure that all modes are interrogated, the mode triggers are interlaced at the SSRP by designating

*See Height, paragraph 2.2.3.

one "Primary", another "Secondary 1", and a third "Secondary 2". The desired interlace of Primary to Secondary mode triggers (e.g., PPS1, PPS2, PPS1, etc.) is inserted at the SSRP and controls the AN/TPX-47 Interrogation Set transmissions.

The SSRP performs pulse width and rise/fall time discrimination on SIF codes received from an aircraft, eliminating garbled codes and noise. If emergency codes appear in two successive sweeps at the same range, they are considered valid and an alarm is generated at the display consoles. SIF returns are sent from the SSRP to two points: (1) the DDG where they are displayed on consoles and used similar to search data; and (2) the SIF processor (SIFP) in the Data Processing module. SIF codes are extracted in the DDG and displayed in readout windows on the console when requested by an operator.

The SIFP validates codes, requiring the same mode and code to be received on two successive sweeps. The SIFP also performs SIF strode elimination to prevent overloading the system with data from a jamming aircraft. An essential function of the SIFP is one of aircraft detection, where the leading edge azimuth, trailing edge azimuth, range and up to three SIF codes are accumulated on each aircraft detected and then transmitted to the computer's I/O buffer. The maximum number of aircraft which can be handled during the 50 millisecond accumulation period is 64.

The system executive function of ORP, after initiating the transfer of detected targets to main memory, relinquishes control to the radar inputs function for further processing of SIF data. The first process is one of pre-correlation where each SIF return is examined to determine in which "track sector" it falls. (Site radar coverage is divided into 64 equal "azimuth track sectors." A circular 65th sector is established, for SIF data in close proximity to the site, whose radius is variable but normally set at 32 nm. This is called the "range track sector".)

Each track which the operator has selected for automatic SIF tracking has two "gates" established for it. The gates are: (1) "non-maneuver gate", defined

as the predicted track location next time the radar "looks" at it, allowing for some minor variation from the extrapolated path; and (2) "maneuver gate", defined as a larger area in which returns from a track may appear if it were to turn or change speed. The azimuth and range track sectors in which each track's gates fall are searched for the pre-correlated SIF data; and data within the gates are paired with the track. This second process is termed "gate building and pairing", and is a preliminary task required by the tracking function.

Other processes are used to detect crossing or merging tracks, multiple flights splitting into separate tracks, to refine processing for tracks which may be maneuvering, and to maintain a history of track-to-data correlation.

2.2.2 Tracking

Three basic methods of tracking an aircraft are used by the system: rate-aided manually initiated track (RAMIT) tracking, automatic SIF tracking, and command tracking. Tracks crosstold in, either by another computer (ADL) or by voice, are treated similar to RAMIT tracks, one exception being that track velocity is crosstold rather than computed.

2.2.2.1 RAMIT. To initiate a track into the system, the scope operator places the ball tab over a point on the scope that he feels represents the position of an aircraft. (This is normally indicated by a radar return.) After activating the action, a zero-velocity track appears on the scope. A second initiation over the next position of the track allows the computer to calculate track speed and heading. Track symbology then is given a velocity vector corresponding to the operator's indicated heading and speed. If the track is to remain on RAMIT, it is the operator's responsibility to monitor radar returns appearing on the scope and manually insert updating information on the track. Otherwise, the computer will extrapolate the track at its last inserted speed and heading. Operator inputs for updating will be used to smooth the track's flight path rather than causing the track to jump to a new position, unless the latter is specifically requested by the operator. Track symbology is updated once per scan in synchronism with the radar's sweep position.

2.2.2.2 Automatic SIF Tracking. Once a track has been entered into the system, an operator may request the system to automatically track it on SIF data. For tracks that are so designated, the radar inputs function correlates SIF returns with the tracks during the gate building and pairing process. The returns are then used by the tracking function in smoothing and predicting calculations to keep track symbology coincident with SIF data trails appearing on the scope. The operator need take no further action on the track. Should the operator deem it necessary to insert speed or heading information, the tracking mode will automatically revert to RAMIT upon his insertion of update data. To return to automatic SIF tracking will require an operator request.

2.2.2.3 Command Tracking. If a system track is paired with another track (for interception, rendezvous, etc.) or some point in space (for combat patrol, close air support, return to base, etc.) it is automatically placed on command tracking. This results in the computer generating an optimal flight path to the desired point. Track symbology of the referent aircraft will follow the calculated path and no attempt will be made to correlate it with SIF data for tracking purposes. The operator is notified by the computer when heading, speed or altitude changes are required of the aircraft in order to maintain the desired path, and he in turn relays these instructions by voice to the pilot. The complete flight path (mission geometry) will be drawn on the scope by the computer at the operator's request. The operator may take the track off command tracking if he so desires, in which case it reverts to RAMIT tracking. He may also return it to command tracking as long as it remains paired with an object.

2.2.3 Height

Height information on a track may be entered into the system either automatically by a Mode 3/C return, or manually by an operator. Tracks being crosstold in will have height information available in their crosstell message. New tracks in the system automatically have their height set at 30,000 feet until some other height is available.

2.2.3.1 Automatic Height. Tracks designated for automatic SIF tracking can have their height updated automatically if the aircraft is capable of transmitting Mode 5/C. The operator can request a Mode 5/C height return by depressing a button labeled "MODE 5" as the PPI sweeps through the aircraft's SIF returns. A Mode 5/C request is sent via the SSRP to the radar. The aircraft's measured height is returned back through the system and the track's height is updated. The height will also be available in readout windows on the display console's face.

2.2.3.2 Manual Height. If Mode 5/C is not available, the operator may obtain a height measurement from the AN/TPS-43 by inserting a button labeled HEIGHT REQUEST as the PPI sweeps through the aircraft's radar return on the scope. The request is transmitted over separate lines to the radar. The response is returned to the DDG equipment and displayed in the digital readout windows on the console face. The operator must then manually insert the height into the computer for the referent track.

In the event only inputs from a 2-D radar are available, the operator must contact a height finder radar by phone, giving the target's range and azimuth, and then manually inserting the height data obtained.

2.2.4 Identification

The identification of aircraft is a manual operation in TACS, and the identity of a track must be inserted by an operator. The identity may be determined by a visual sighting by pilots or observers on the ground; by correlation with a flight plan; by receipt of special SIF code; by receipt of identity information from another CRC/CRP or AADCP; or by other such information available to Movements and Identification personnel.

All newly initiated tracks appear on the scope with an identity of "pending"--with one exception: if an action is taken to pair an airbase (rather than a fighter) with a target, a new zero-velocity track with an identity of "fighter" will be generated in the vicinity of the designated airbase.

Tracks whose identities are changed to "pending", "unknown", "hostile", "faker", and "X-ray" and are not paired upon, cause an alarm to be generated on the SD and WAO consoles. Tracks received at the CRC via ADL from an AADCP with identities of "unknown" will be converted to "pending" by the ADL function.

2.2.5 Airborne Weapons Control

The objective of the airborne weapons control function is to determine what maneuvers an aircraft must take to reach the target it is paired with in the least possible time. Major factors which must be taken into consideration include:

Target track data

- speed, heading, altitude

Controlled aircraft characteristics

- acceleration and deceleration rates
- climb and descent rates
- maximum altitude and speed
- preferred tactic
- weapons carried

Maneuvers

- attack speed, altitude and heading
- cruise speed, altitude and heading
- offset (turn) points
- time delay between calculations and actual aircraft maneuver
- winds

The weapons function calculates the required mission geometry and displays the needed information to the responsible weapons controller. He will in turn transmit speed, heading and altitude changes, as well as target range and bearing, to the pilot.

The weapons function validates mission geometry at least once per radar scan using a miss distance algorithm. Recalculations will also occur whenever

the system detects a change in any factor included in mission geometry calculations. An alarm is forced to the weapons controller when a change is detected that should be communicated to the pilot.

The weapons controller also has the option of overriding almost any factor in order to achieve a difference solution to system calculations. Should the computer malfunction, the controller is capable of making adequate calculations manually to vector the controlled aircraft to the proper intercept point.

2.2.6 Air Defense Artillery

If it is desired that a target be intercepted by surface-to-air missiles, an "engage" action may be taken which results in a track message being transmitted to a referenced AADCP. If the action is taken on a target against which a fighter is also paired, the weapons controller and ADALO are notified by a Simultaneous Engagement alarm. The alarm condition is removed by depairing the fighter or canceling the AADCP engagement. The AADCP's computer system will acknowledge receipt of the track message and will in turn transmit kill/no kill information back to the CRC.

The CRC commander may request that an engaged AADCP cease fire or hold fire by inserting appropriate information into the computer which results in a message containing the command being transmitted via ADL to the AADCP. Appropriate visual displays are also generated at consoles in the CRC. The commander may also alert the AADCP to "weapons free" or "weapons tight" conditions by console switch action.

2.2.7 Crosstelling

The transmission of information between a CRC and a CRP, AADCP, TACC or another CRC may be accomplished over automatic data link (ADL) lines or by voice. When it is necessary to transmit information on a track carried in the system, the operator specifies the track and its destination in the console

buttons. If data link lines exist to the destination, the appropriate messages will be made up and automatically transmitted. They will be periodically re-transmitted until the receiving site acknowledges receipt of the information. Acknowledgement is automatic if the site's computer is operating.

If data link lines are down, or the receiving site is not equipped to receive data link communication, one or more console operators will have been designated as track tellers and the information to be transmitted by voice will be presented to them in an ARO. The computer places the tracks to be told by a teller in a first-in/first-out sequence. When the teller completes transmission of a track's information he need only depress the "tell sequence" button and the next track to be told appears on the ARO. The sequence is a closed loop, returning to the first track when the last has been displayed. This manual operation is termed Computer Aided Manual Track Telling (CAMTT).

It is the responsibility of the Air Surveillance Officer (ASO) to determine data link line status and to designate which operators will be responsible to tell track information to which sites. He is aided in this task by the ADL function which continually transmits to, and receives test messages from, tied sites. The computer generates an alarm on the ASO console when it appears data link communication with a site is no longer possible.

Messages to be processed by the ADL function as of the time this report was written includes:

Test (M.O.)
Track information (M.2)
Track amplifying (M.8)
Track management (M.9A, M.9B)
Controlled aircraft command (M.10A)
Controlled aircraft status (M.11H)
National (utility information) (M.12A)
SAM system status (M.14)
SAM command (M.15)

Once a track has been designated for crosstelling, ADL will continue to tell the necessary information at a site adapted frequency until either the track is handed over to the receiving site or a "cease tell" action is taken.

The site registration function provides a capability to maintain and refine parameters used in transforming track data from each adjacent site. Initial values are taken from adaptation. After that, the disparity between a track's position during crosstell-in and after it is accepted by the local site will be used in updating the adjacent site's registration. The ASO can also force re-registration if he so desires.

2.2.8 Adaptation

The adaptation function provides the capability of entering tactical, geographic and meteorological data into the computer, during initiation of the system or in real time, that are peculiar to the referent facility. The data fall into eight categories:

- Winds aloft
- Magnetic variation at the radar site
- Maps and fixed point locations
- Fighter characteristics
- Site configuration
- Data link configuration
- Adjacent site registration

Data may be inserted either by punched tape or by keyboard. In some cases (e.g., map data) they may also be entered or deleted by console switch action. Adaptation is considered dynamic because it can be modified in real time.

2.2.9 Recording and Data Reduction

The recording and data reduction capability of the AN/TSQ-91 system was designed primarily to facilitate computer program checkout and trouble-shooting. The capabilities provided for output of data and for formatting of data are designed to facilitate verification/check of the content of items, where an item is defined as a data group stored in a given table or location.

Recording of this data at specified times or following specified transformations requires input of instructions from a recording request tape to the Operational and Recording Program (ORP). The ORP has three major divisions: the executive function, or control; the operational functions, such as tracking, weapon assignment, weapon direction, etc.; and the recording function.

Recording will not be accomplished unless a recording request tape has been generated and has been input to the ORP. The generation of the recording request tape is performed by the computer operator on the keyboard/printer/punch using the Simulation and Data Reduction Program (SDRP) to generate a punched paper tape. The computer operator may specify from one to six "requests." Each request specifies a condition which will require recording of data and then specifies the data to be recorded when the condition occurs. For each request, up to 64 blocks of data can be specified to be recorded.

The computer operator, during operation of the ORP (assuming a recording request tape has been input) specifies the recording mode by keyboard action. The recording modes are test or shakedown. The test mode is the normal mode for recording during operations. Specifying this mode directs the computer to record on the recording magnetic tape. In the recording process, recorded data is initially stored in a Data Recording Output Buffer. When the output buffer is full (1,024 computer words) or recording of a request is complete, the contents of the buffer are transferred to the recording magnetic tape. If the buffer reaches 1,024 computer words during execution of a recording request, any remaining data to be recorded for the request is not recorded. Two recording tapes are available for recording. Data recorded include: identifier of the table recorded or core location of first word recorded; time, to the second, of the recording; and data recorded.

The recording process interrupts execution of other ORP functions. In the test mode, if this interruption results in delays which would cause system response time to exceed specified limits, recording ceases. In the shakedown mode, recording or printer output, as specified, continues without regard to system response time limits.

The shakedown mode will normally be specified only for detailed trouble-shooting of the system. In this mode, the computer operator may specify, for each request, that recording be output either on a magnetic tape or directly on a line printer. Magnetic tape records are generated in the same manner as indicated for the test mode. Output on the line printer is immediate with the data printed out as an octal representation of the tables or register locations specified in the request.

In addition to processing recording requests, approximately every fifteen minutes the ORP automatically records "safe data" (adaptation data) on another magnetic tape. For the AN/TSQ-91, "safe data" are those adaptation data that are essential to reconstitute the system, should the computer malfunction and the system be forced into a startover mode. The air surveillance data (track data) must be rebuilt following a startover.

Data reduction is the process which transforms/transfers recording tape content into a form readable by operator personnel. The recording magnetic tape data are input to the SDRP and computer operator keyboard action specifies the format for reduced data output. It should be noted that both the production of recording request tape and data reduction requires the use of the HM 4118 computer; thus, the CRC must revert to manual operations or be relieved of operational responsibilities during these operations.

The options which are available to the computer operator for specifying reduced data content and format are:

- Specification of data output
  - magnetic tape
  - punched tape
  - line printer output
- Specification of data records to be reduced
  - request set
  - date/time of data to be reduced

- Specification of alphanumeric title for each page of reduced data and headings for columns
- Specification of spacing between lines of data
- Specification of number of lines to be output as a unit
- Specification of output format
  - items to be output
  - location of items on page
  - representation of item in octal, decimal, or integer value
- Qualifiers controlling output
- Conversions
  - knots to mach
  - mach to knots
  - Rho, theta to x, y

2.2.10 Monitoring and Self-Test

Monitoring of the AN/TSQ-91 is performed by the computer operator at the System Status Panel in the automatic mode and by the Senior Director (assisted by all operational personnel) by visual observations in the manual mode. The operator has the self-test function of the system to provide notice of fault.

The self-test function provides a fault detection and limited fault isolation capability in the system hardware accessable by software. The following elements are tested:

- Computer logic
- Display subsystem
- Peripheral equipment
- SIF subsystem
- Automatic data link

The first three elements are exercised in their entirety as a part of system startup. Once the system is cycling, computing logic is tested once per scan; the display system is tested each display frame (50 milliseconds); magnetic tape synchronizer/transport and operator station buffer are tested every 15 minutes, the SIF subsystem checks test targets and will notify the maintenance operator when errors occur or if a test message hasn't been received in 15 seconds; and the ADL system is tested upon operator request.

The system executive function of the ORP provides a startover capability in the event of a malfunction occurring in an operating program. When equipment sensors detect a program "halt" or "closed loop" a startover is forced and the computer operator is notified of the malfunction and its probable cause or location.

2.2.11 Simulation

In addition to the generation of recording request tapes and the reduction of recorded data (discussed in paragraph 2.2.9), the Simulation and Data Reduction Program (SDRP) is used to generate a switch action history tape, to generate a trial tape, and to generate a simulation tape.

The simulation tape is generated by the SDRP as a magnetic tape by utilizing the following inputs:

- Target generation data
- Console input data
- Automatic data link data
- Core modification data

The console operator produces the input data on paper tape utilizing the keyboard/printer/punch from scripted information.

The simulation tape provides the capability to test the entire system operation of the ORP.

The trial tape provides the capability to exercise or test proposed modifications to the ORP during a simulation run. The modifications are input to the ORP as Core Modification data.

The switch action history tape is produced by a function of SDRP which is a combined recording-simulation capablity. The function allows for the reduction of switch action inputs, which were recorded live, into a tape which can then be used to generate a simulated switch-action tape. This tape provides the programmer the capability to play back the switch actions in non-real time to trouble-shoot the ORP.

The use of the switch-action history tape, the trial tape, or the simulation tape is controlled by the Program Exercise subroutine of the ORP executive function. This subroutine only operates when the computer is in the shakedown mode of recording and a simulated tape is a legal input. At other times, the ORP executive does not allow the Program Exercise subroutine to operate.

The Program Exercise subroutine inhibits the processing of inputs from all other sources except elements of the self-test system and the magnetic tape synchronizer; thus, no live radar, SIF, or automatic data link data are processed by the ORP. Nor can operational personnel take switch actions. The primary purpose of simulation in the AN/TSQ-91 is testing and verification of the system functions in a controlled environment. Operational personnel can receive very little training by this passive (observation only) method.

2.2.12 Utility Programs

The utility programs are designed for use by the programmer in maintenance of system programs. In performing these functions, the utility system utilizes three programs: the monitor, the assembler and the utility group. The monitor program performs as an executive program for the utility programs, and controls overall operation during compilation or modification. The assembler program translates symbolic statements into machine language and assigns storage

locations to these instructions and other elements of the source program. The assembler program also allows the performance of auxiliary program functions designated by the programmer. The utility group serves as a tool in testing, correcting, reproducing, listing, and generating system programs.

2.2.13 Programming Language

The language used in programming the HM 4118 is a machine level language called HAP-18M. It is made up of symbols, constants, operators, and expressions that are used to define memory locations, instructions, and operands. Additional coding is provided in the form of pseudo-operations and macro-operations, which afford further programming flexibility. HAP-18M symbols consist of six or less alphanumeric characters with the first character being alphabetic. An asterisk (*) may be substituted for a term in an arithmetic expression in an instruction variable field. A line that begins with an asterisk is defined as being entirely in the comments field. Symbols may be used to define memory locations. HAP-18M constants are considered decimal integers except for those used in operands of switch instructions, in Boolean expressions, and in certain data generated during pseudo-operations. Constants that are not decimal integers are considered octal integers. Four special symbols are provided denoting the four basic arithmetic or equivalent Boolean operations.

2.2.14 Video Maps

Although video maps are not part of the computer system, to the console operator they will appear as such. Three separate maps are available, in any combination to provide an earth surface reference for the air situation as viewed by the operator on the PPI. The maps are scanned by a video mapper in the data processing module and routed to the DDG for display. These maps can be produced or modified readily on site as the situation demands. Since they are not part of the computer system, they are available to console operators even when the system is in a manual mode.

A limited map generation capability exists in the computer system which allows operators to generate up to twenty line segments to depict short term features such as battle fronts, landing zones, attack corridors, etc. This feature is supporative of the video mapping system and used to enhance the previously prepared maps. It is not available in the manual mode.

2.3 CRC OPERATIONS

The CRC, the operational element immediately under the TACC, contains the prime control radars of TACS. The CRC supervises activities of subordinate radar elements and collects information on all air activities within radar and radio range using organic and subordinate element equipment. This information is then displayed, evaluated, and disseminated throughout the TACS. Within its assigned area of responsibility, the CRC provides control of defensive and offensive missions, navigational and air rescue assistance, threat warning for friendly aircraft, and the means for air traffic regulation and identification. When so authorized by the TACC, the CRC scrambles and diverts aircraft, designates air defense warning conditions, and specifies weapons control status.

2.3.1 Defensive Missions

Defense mission control involves the detection and identification of hostile airborne objects, issuance of scramble orders to interceptor aircraft on alert or diversion of airborne aircraft, vectoring of the aircraft to a position which will assure mission accomplishment, processing the mission report, and vectoring the aircraft to additional targets or an intended point of landing.

During joint operations, the CRC is responsible for assigning appropriate hostile airborne targets to the Army Air Defense units. This is accomplished through close coordination with the Army Air Defense Liaison Officer assigned to the CRC and the AADCP. To assure this close coordination, the AADCP is electronically connected to the CRC.

Air defense activities are conducted in accordance with the Rules of Engagement and Coordination Procedures issued by the Area Air Defense Commander.* These rules and procedures provide for:

- Centralized control of resources and maximum decentralization of execution authority to engage hostile air targets commensurate with identification capability.
- Rapid reaction.
- Minimum interference among friendly forces.
- Coordination of effort and unity of action.

2.3.2 Offensive Missions

Offensive mission control consists primarily of providing guidance for tactical aircraft from an airfield to a target area in which the pilot assumes control for visual attacks or to a handover point for control by a Tactical Air Control Party. Upon termination of the attack, the CRC processes in-flight reports and provides the aircraft guidance to follow-on targets or to the intended point of landing.

2.3.3 Air Traffic Control

Air Traffic regulation and identification is performed by the Air Traffic Regulation Center which is an integral element of the CRC. The ATRC is the primary operational element for providing single-system managership by the Air Force Component Commander of all airspace over the combat zone. For effective air defense, positive regulation and identification of all air vehicles moving within the airspace over the combat zone are mandatory. To minimize interference between friendly forces and to maximize safety for all friendly air vehicles, positive regulation must be exercised. "Regulation" includes the functions of air traffic control by radar or other means, monitoring or flight following, navigational assitance and advisory service, assignment of airspace for specific purposes, and coordination.

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*The commander of a unified or joint command normally will appoint the Air Force Component Commander as Area Air Defense Commander who in turn normally appoints the CRC Commander as the Region Air Defense Commander.

The ATRC will regulate all friendly air traffic according to directives issued by the Area Air Defense Commander which are based on general priorities and restraints established by the commander of the unified or joint command. These directives will establish rules and procedures for air traffic regulations and identification to include:

- Control points.
- Arrival, departure, enroute, and hand-off procedures.
- In-flight reporting procedures.
- Altitude and area coordination procedures for visual and instrument flights.
- Airways structure when necessary for air traffic control.
- Procedures for integrating other military service air movement data produced by other related systems.
- Procedures for temporary assignment of airspace for use by other military services.

The ATRC will be electronically connected with external and other military service control systems and have rapid access to the air movement data of all other related control systems. The Army Flight Operations Center will normally be collocated with the CRC/ATRC.

APPENDIX A. ABBREVIATIONS

AADCP	-	Army Air Defense Command Post
ACM	-	Air Conditioning Module
AC&W	-	Aircraft Control and Warning
ADALO	-	Air Defense Artillery Liaison Officer
ADL	-	Automatic Data Link
AEM	-	Ancillary Equipment Module
*AFCC	-	Air Force Component Commander
AFCCP	-	Air Force Component Command Post
*AIMS	-	Air Traffic Control Radar Beacon System, Identification Friend or Foe, Mark Secure Identification Friend System, System
ALO	-	Air Liaison Officer
*ARO	-	Auxiliary Readout
*ASO	-	Air Surveillance Officer
ASR	-	Airport Surveillance Radar
ATC	-	Air Traffic Control; Air Traffic Controller
ATRC	-	Air Traffic Regulation Center
AWC	-	Air Weapons Controller
bpi	-	bits per inch
bps	-	bits per second
CAMTT	-	Computer Aided Manual Track Telling
CDC	-	Common Display Controls
*CE	-	Console Electronics
*CM	-	Console Module
CP	-	Command Posts
CRC	-	Control and Reporting Center
CRP	-	Control and Reporting Post
DASC	-	Direct Air Support Center
DDG	-	Data Distribution Group
*DPM	-	Data Processing Module
FAC	-	Forward Air Controller
FACP	-	Forward Air Control Post

*Abbreviation shown differs from U.S. Army Authorized Abbreviations and Brevity Codes (AR 310-50).

FEBA - Forward Edge of Battle Area
G/A - Ground-to-Air
GCA - Ground Controlled Approach
G/G - Ground-to-Ground
GDM - Group Display Module
HF - High Frequency
Hz - Hertz
IFF - Identification Friend or Foe
IFR - Instrument Flight Rules
I/O - Input/Output
KPP - Keyboard/Printer/Punch
MACCS - Marine Air Command Control System
MHz - Megahertz
M&I - Movement and Identification
Modem - Modulator/demodulator
*ms - millisecond
*MTS - Magnetic Tape Synchronizer
*MTU - Magnetic Tape Unit
MW - Microwave
MWave - Microwave
*NM - Nautical Mile
NTDS - Navy Tactical Data System
ORP - Operational and Recording Program
OSB - Operator Station Buffer
PAR - Precision Approach Radar
*PEB - Peripheral Equipment Buffer
PPI - Plan Position Indicator
PPS - Pulses Per Second
RAMIT - Rate-Aided Manually Initiated Track
RAPCON - Radar Approach Control Center
RRM - Radar Remoting Module
SAM - Surface-to-Air Missile
*SD - Senior Director

*Abbreviation shown differs from U.S. Army Authorized Abbreviations and Brevity Codes (AR 310-50).

SDRP	-	Simulation and Data Reduction Program
SHF	-	Super High Frequency
SIF	-	Selective Identification Feature
SIFP	-	Selective Identification Feature Processor
SSB	-	Single Side Band
SSO	-	Search Scope Operator
*SSP	-	System Status Panel
SSRP	-	Secondary Surveillance Radar Processor
*TAB	-	Tactical Air Base
TABCOMM	-	Tactical Air Base Communications
TACC	-	Tactical Air Control Center
TACP	-	Tactical Air Control Party
*TACS	-	Tactical Air Control System
TADIL	-	Tactical Digital Information Link
TADS	-	Tactical Air Defense System
*TAS	-	Tactical Air Support
TATCF	-	Terminal Air Traffic Control Facility
TOC	-	Tactical Operations Center
µsec	-	microsecond
UHF	-	Ultra High Frequency
UP	-	Utility Program
VFR	-	Visual Flight Rules
VHF	-	Very High Frequency
WAO	-	Weapons Assignment Officer
*WD	-	Weapons Director

*Abbreviation shown differs from U.S. Army Authorized Abbreviations and Brevity Codes (AR 310-50).

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Specification No. CP-201103-B. "Data Processing Module for Tactical Air Control System 407L." Volume 1 of 2.

Specification No. CG-201805-A. "Simulation and Data Reduction Computer Program Design Specification for the CRC/CRP Operations Center for Tactical Air Control System 407L." Volume 1 & 2 of 3; Parts 1 and 2.

Specification No. CG-201807-A. "Operational and Recording Program for the CRC/CRP Operation Center for Tactical Air Control System 407L." Volumes 1 through 5; Part 1 of 2.

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TM-LX-249/000/02. "External Interfaces of 407L Operations Centers."

TM-LX-305/200/01. "Tactical Air Control System Category II Test Team Training Materials: Orientation."

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